PHASE II SITE CHARACTERIZATION REPORT
FOR THE
SILVER CREEK DRAINAGE PROJECT

Lewis & Clark County, Montana

Prepared For:

Mr. Vic Andersen and Mr. Ben Quiñones
Montana Department of Environmental Quality
Remediation Division
Mine Waste Cleanup Bureau
2209 Phoenix Avenue
P.O. Box 200901
Helena, Montana 59620

Submitted by:

Olympus Technical Services, Inc.
765 Colleen
Helena, Montana 59601

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1.0 INTRODUCTION

This document was prepared for the Montana Department of Environmental Quality/Mine Waste Cleanup Bureau (DEQ/MWCB) by Olympus Technical Services, Inc. (Olympus) under DEQ Contract No. 401026. This report presents the results of Olympus' work on the Phase II site characterization of the mine/mill waste areas identified in the Silver Creek drainage basin.

The project was completed according to the sampling approach for the Silver Creek Drainage Project Phase II Detailed Site Characterization as described in the Phase II Field Sampling Plan (DEQ-MWCB/Olympus, 2002a), which contains the Standard Operating Procedures (SOPs) for conducting the field sampling activities. Supporting documents for the Phase II FSP include the Quality Assurance Project Plan (QAPjP) that describes quality assurance procedures for the field and laboratory data for the project (DEQ-MWCB/Olympus, 2002e), the Health and Safety Plan that describes practices and procedures to minimize exposure to hazardous materials and to reduce the possibility of physical injury (DEQ-MWCB/Olympus, 2002c), and the Laboratory Analytical Plan (DEQ-MWCB/Olympus, 2002d). In addition to the Phase II Detailed Site Characterization, Olympus also completed a Phase I Reconnaissance Site Characterization of the Silver Creek Drainage as described in the Phase I Field Sampling Plan (DEQ-MWCB/Olympus 2002b).

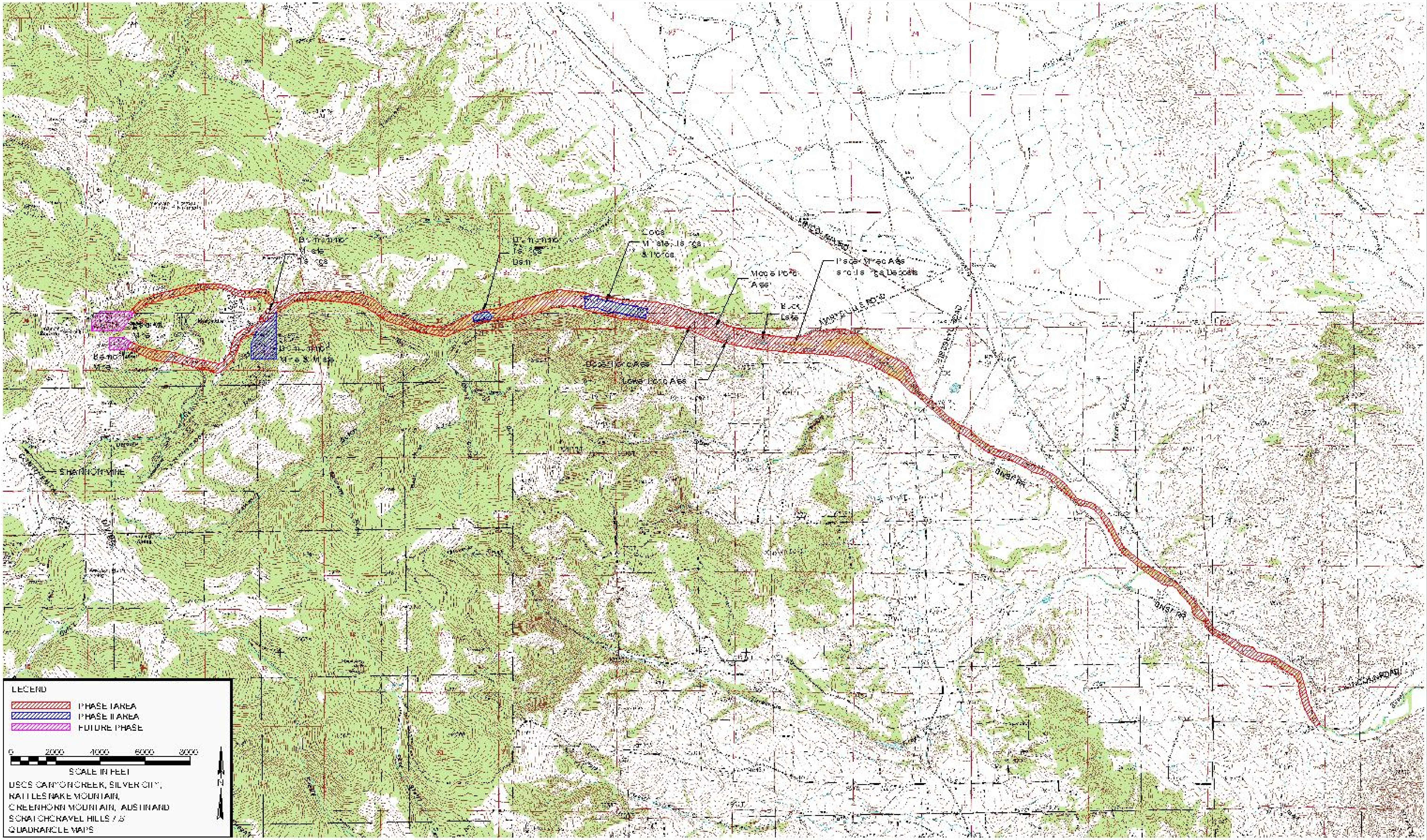
1.1 PROJECT DESCRIPTION

The Silver Creek Drainage Project is located approximately 15 miles north of Helena, Montana. The headwaters of the basin are located on the east side of the Continental Divide near the historic mining community of Marysville and the project encompasses a portion of the Marysville Mining District.

The project area is located in Lewis & Clark County, Montana within Sections 35 and 36, Township 12 North and Range 6 West; Sections 31, 32, 33 and 34, Township 12 North, Range 5 West; Sections 1, 2, 3 and 5, Township 11 North, Range 5 West; and Sections 6, 7, 8, 16, 17, and 21, Township 11 North, Range 4 West, Montana Principal Meridian (Figure 1-1). This figure shows the approximate boundaries of the project and the location of Phases I and II of the characterization. Figure 1-2 is a composite of aerial photographs taken in 1995 showing an overview of the Silver Creek Drainage Project Phase II work area. More detailed aerial photographs are presented to show the Marysville and Drumlummon mine, millsite and millsite tailings areas (Figures 1-3 and 1-4), and the Drumlummon tailings, Goldsil millsite and tailings, Upper Pond Area tailings, Middle Pond Area tailings and the Lower Pond Area tailings (Figures 1-5 and 1-6).

The site is accessed by proceeding north on Interstate 15 from Helena approximately 8.2 miles to Exit 200, proceeding west on Highway 278 (Lincoln Road) for approximately 9.5 miles and turning left (west) onto Marysville Road. The Marysville Road runs along Silver Creek for approximately 5 miles. The lower portion of the project area can be accessed by turning off of Lincoln Road onto Silver Creek Road. The downstream project boundary is located where the Burlington Northern & Santa Fe Railway intersects Silver Creek Road.

The Silver Creek Drainage Project area is located on patented mining claims, public land and private land. The site is comprised of the Silver Creek streambed, banks and floodplain,



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

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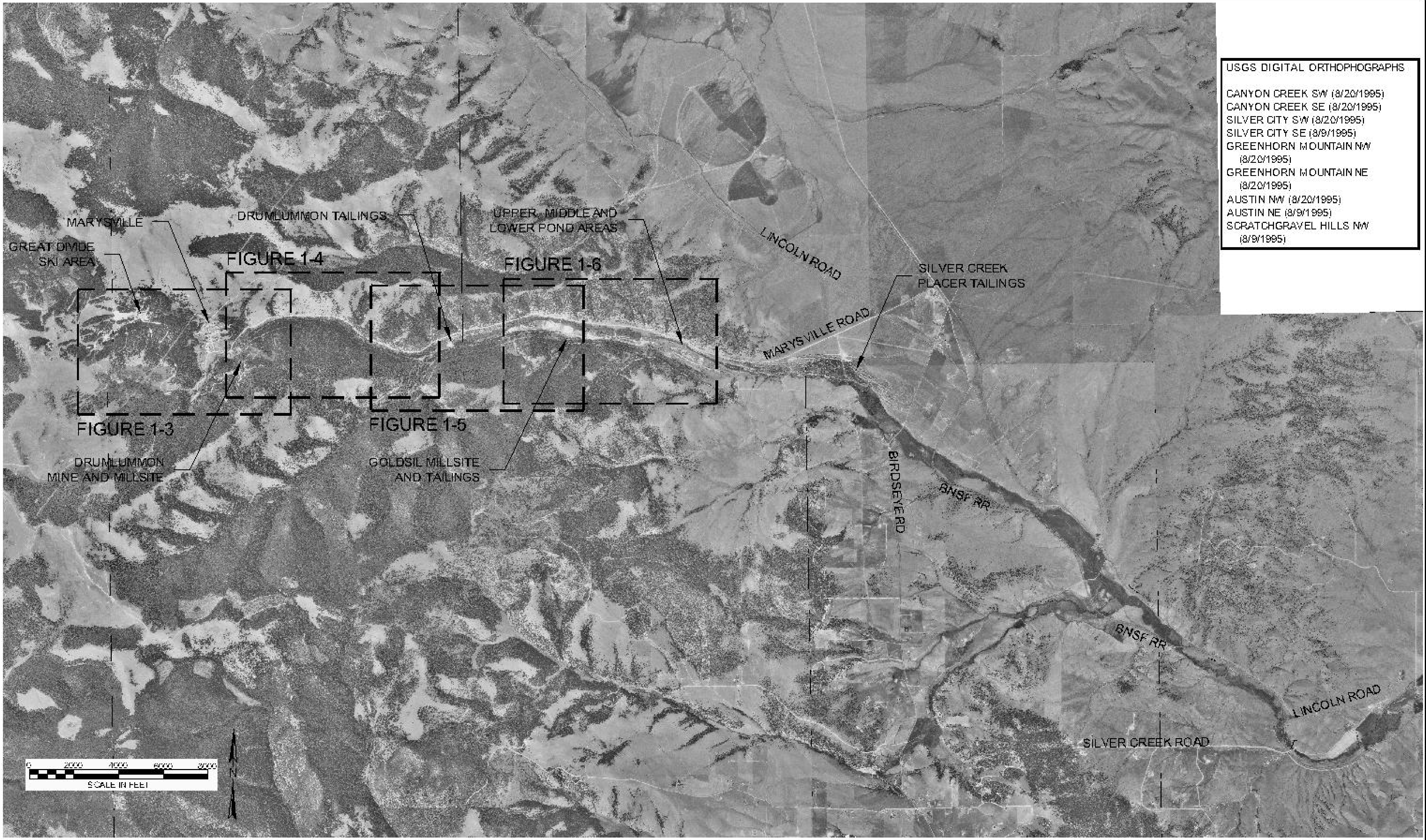
SILVER CREEK DRAINAGE
PROJECT OVERVIEW MAP

FIGURE
1-1



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE CHARACTERIZATION
LEWIS & CLARK COUNTY, MONTANA

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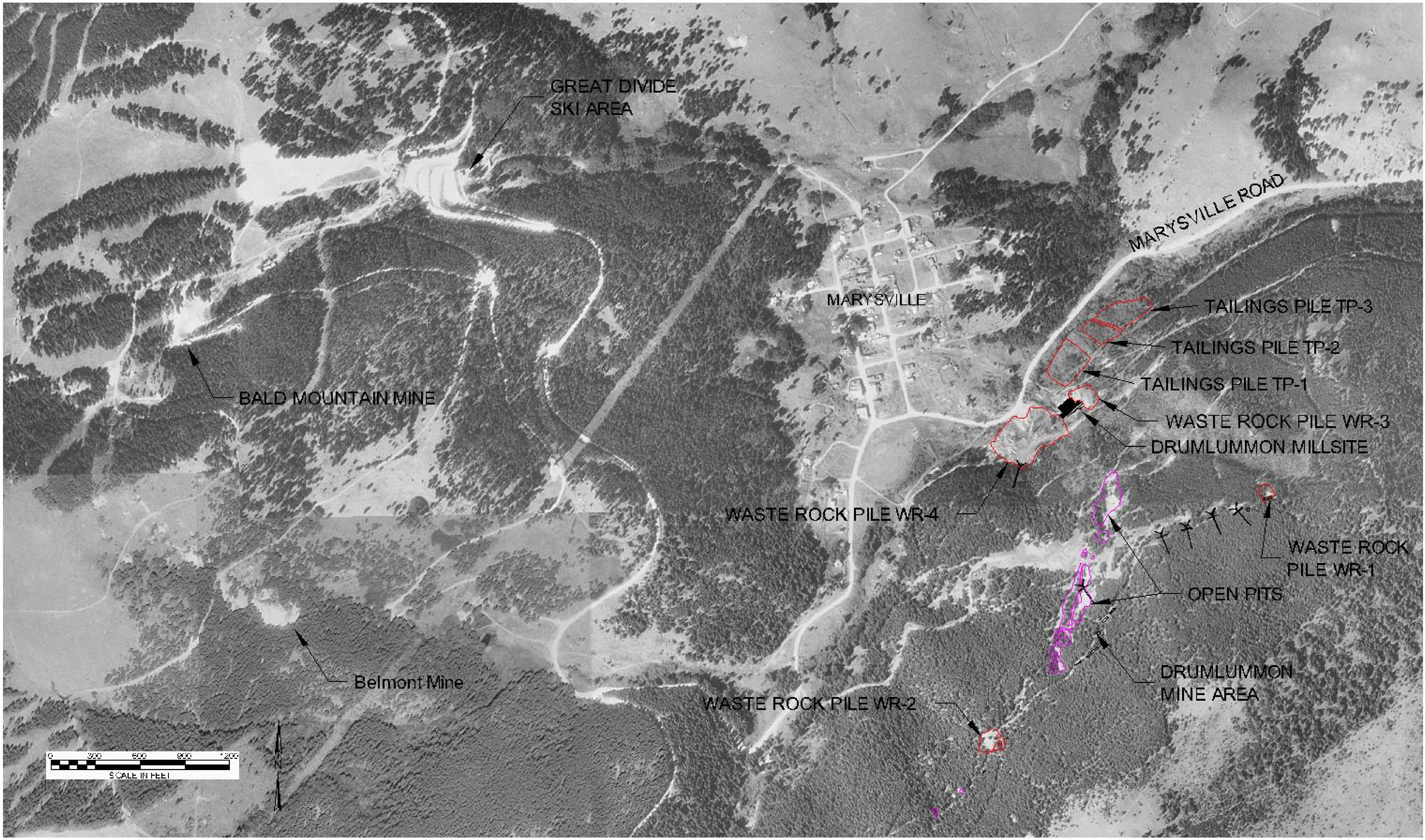
AERIAL PHOTOGRAPH OF THE SILVER CREEK DRAINAGE

FIGURE 1-2



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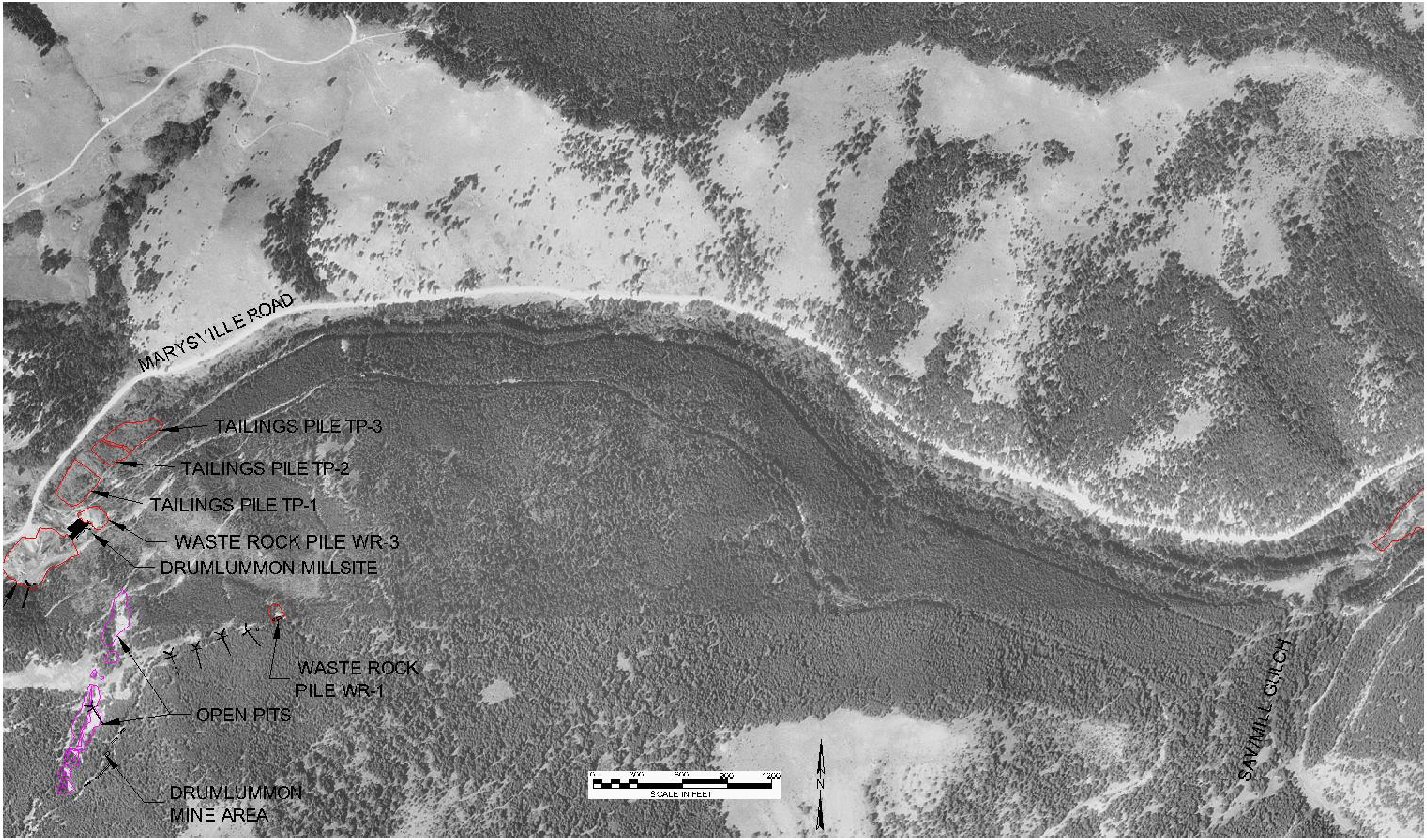

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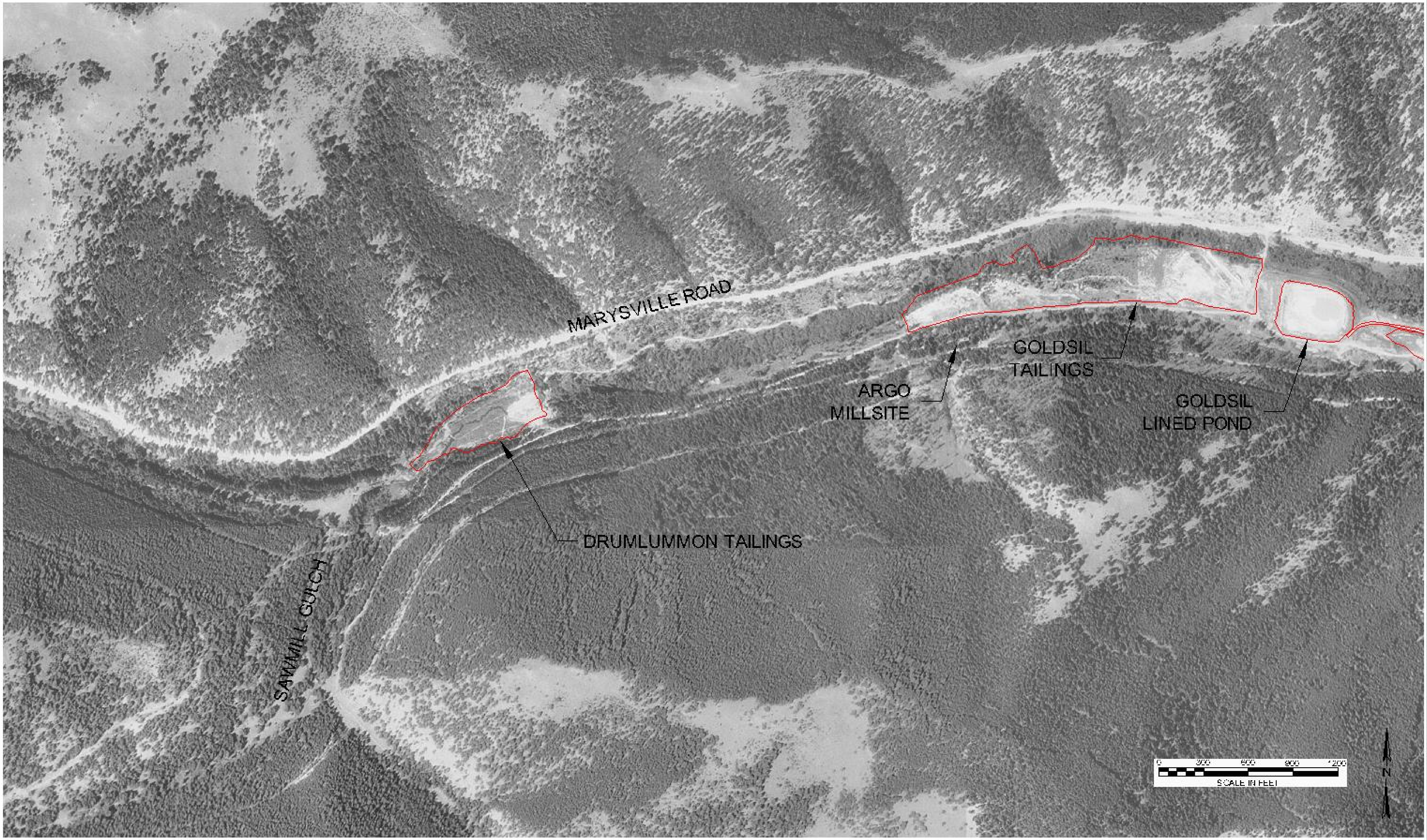
SILVER CREEK ABOVE SAWMILL GULCH

FIGURE 1-4



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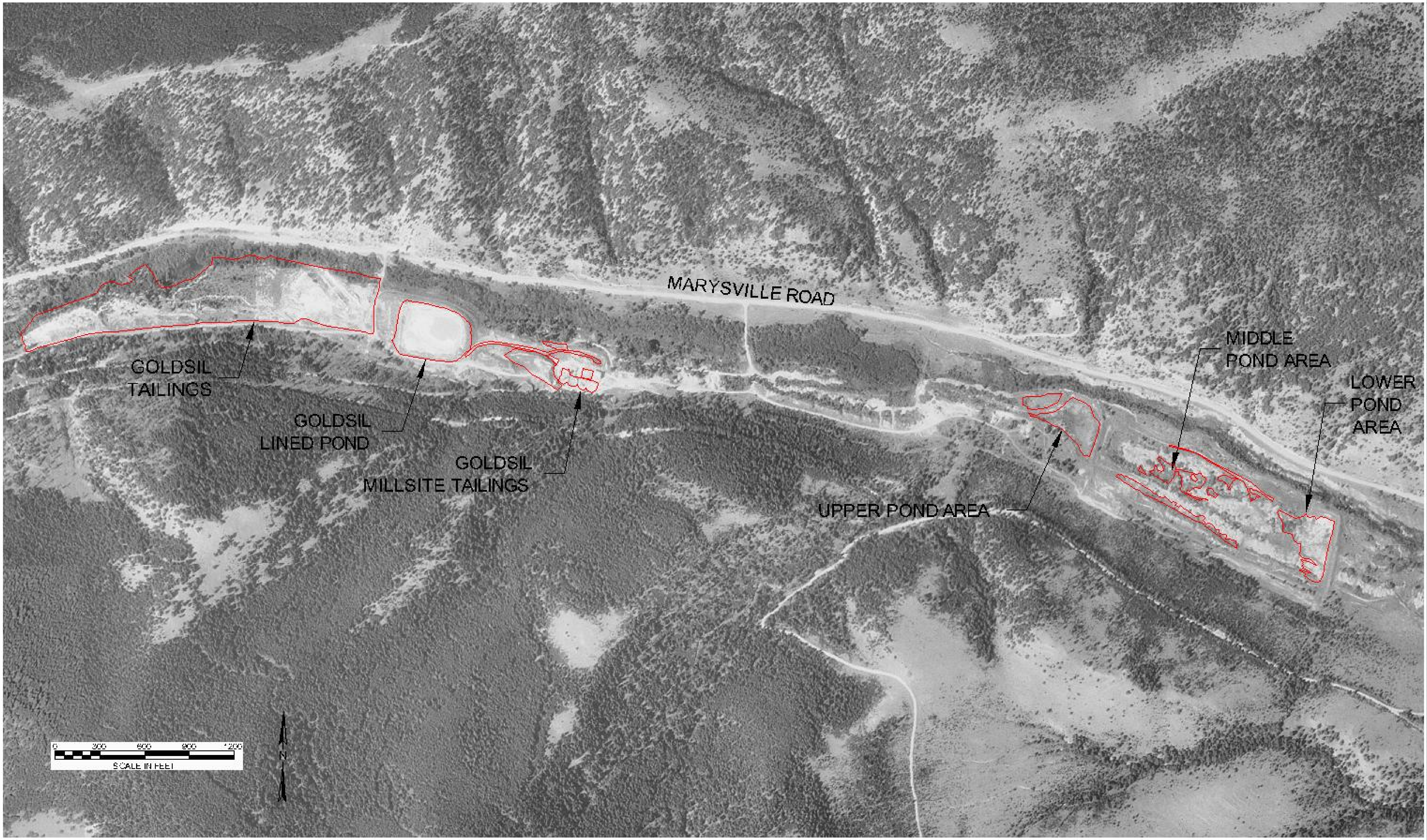

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SILVER CREEK DRAINAGE CHARACTERIZATION
LEWIS & CLARK COUNTY, MONTANA

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GOLDSIL AND UPPER, MIDDLE AND LOWER POND AREAS

FIGURE 1-6

Jennies Fork, a tributary to Silver Creek, and several abandoned mine/mill sites and associated waste piles and a large area of placer mine tailing piles. The focus of the Phase I Reconnaissance Site Characterization is the Silver Creek and Jennies Fork streambed, banks and floodplain, and the placer tailings piles. The focus of the Phase II Detailed Site Characterization is the Drumlummon mine, millsite, and millsite tailings areas, the Goldsil millsite and tailings area and additional smaller tailings piles identified during the Phase I Reconnaissance Site Characterization.

1.2 PROJECT OBJECTIVES

The objective of the Phase II Detailed Site Characterization is to collect sufficient data to perform a risk assessment and detailed analysis of reclamation alternatives for the Drumlummon and Goldsil sites. The data required to support each of these tasks are summarized as follows:

Risk Assessment Data Requirements:

- Establish background soil concentrations with at least 4 background samples;
- Characterize vertical and lateral metal concentration variations in waste sources and assess the 0 to 6 inches zone for direct contact and air emission potential;
- Evaluate the physical and chemical properties of the source material that may affect contaminant migration including: pH, metal concentrations, leaching potential, acid/base accounting, and particle size distribution;
- Inventory solid and hazardous waste materials on site associated with past mining operations;
- Assess physical hazards associated with potential open adits or shafts, pits, trenches, highwalls, and dilapidated structures, etc; and
- Assess surface water and groundwater uses.

Feasibility Study Data Requirements:

- Accurate areas and volumes of the contaminant source materials (mill tailings and waste rock);
- Contaminant concentration variations and leaching characteristics of the waste;
- Groundwater characteristics in the vicinity of potential repository areas;
- Physical characteristics and dimensions of open accesses to underground mine workings (if any);
- Revegetation parameters for cover soil sources including soil texture and grain size, nitrogen, phosphorus, potassium, percent organic matter, pH, and conductivity;
- Hydrologic configuration of Silver Creek in the vicinity of the tailings piles;

- Optional locations and soil characteristics for repository sites; and
- Identification of potential borrow source areas for cover soil.

2.0 BACKGROUND INFORMATION

2.1 MINING HISTORY

The historic name of the Marysville mining district is the Ottawa mining district. The only town in the region, Marysville, is about 18 miles northwest of Helena. Silver Creek, which begins just above Marysville, runs eastward 16 air miles before discharging into Lake Helena. The gold-bearing gravels found in Silver Creek for four miles below the town were first discovered in 1862, but the richer bars were not worked until May of 1864. The pay streak was from 30 to 50 feet wide and gold was found on the bedrock 15 to 20 feet from the surface. The gold was valued at only $14 per ounce (as opposed to $17 gold from Last Chance Gulch) due to its high silver content. The stream was worked by hydraulicking, and the side bars in the gulch were said to have paid well. While no production figures are available for the early years and from 1870 to 1880, in 1869 the stream produced $50,000. Later in the 1880s, the district produced from $9,000 to $15,000 in placer gold. The stream has been estimated to have produced a total of $3,000,000 (Pardee and Schrader, 1933; Goodale, 1915; Axline, 1991).

Placer mining activities in the drainage occurred at various time periods. Approximately 75% of the activity was on Silver Creek, with the remaining activity on tributaries. Placer activity was reported to be sporadically active from the 1860s through 1921. Gold production through this time period is reported at $3.2 million (Lyden, 1987). Other periods of placer mining activity were in 1933 and from 1937 to 1941. During the period 1937 to 1941, a dragline dredge worked on bench and creek placers from the Silver City-Seven Mile Creek county road (Birdseye Road) upstream to within a short distance of the lowermost of several old tailings ponds, a distance of approximately 2 miles. Approximately 1,000,000 cubic yards of material were processed in this stream reach as a result of the dredging activity (Lyden, 1987). Although it is not known what separation processes were used in this operation, mercury was historically used as an amalgam to remove gold and silver from the black sand concentrates recovered by the dredges.

Hardrock mining in the drainage began about 1875 with the discovery of the lode gold deposits of the Drumlummon mine by Thomas Cruse. Major metal commodities were gold, silver, zinc, lead, and copper. The period of greatest prosperity for the area was from 1875 to 1921 (Lyden, 1987). The major hardrock mines in the Silver Creek drainage basin include the Drumlummon, Belmont, Bald Mountain, and Shannon mines. These mines, together with several other mines on the west side of the Continental Divide, likely produced over 30 million dollars of gold from 1875 through 1913 (Knoph, 1913). The mine workings in the headwaters area consist of numerous adits, small trenches and pits with associated waste rock dumps. Some of the workings are located high on the Continental Divide ridge line above the gulches on very steep terrain.

The lode mineral deposits in the Marysville Mining District are veins which have been categorized into the Drumlummon type and the Towsley Gulch type (McClernan, 1983). The Drumlummon type consists of platey calcite gangue and gold with minor sulfides, including tetrahedrite, chalcopyrite, pyrite, sphalertite, and galena. Manganese staining is prevalent in the ore, which occurs in shoots through the veins. The highest grade ore reportedly occurred near the surface in these veins, likely due to supergene enrichment. The Towsley Gulch type of veins are typified by more abundant sulfides with significant silver and lead values. These veins also contain abundant rounded fragments of country rock resembling a sedimentary conglomerate.

Mill production records for the various mine sites were reported by McClernan (1983). For the period of 1909 to 1948, total production for the combined Drumlummon, Belmont, and Bald Mountain mines was approximately 25,000 ounces of gold and 61,000 ounces of silver from 118,000 tons of ore. For the period of 1901 to 1948, production from the Drumlummon mill was approximately 116,000 ounces of gold and 853,000 ounces of silver from 480,000 tons of ore. Additional ore from the Drumlummon mine was likely processed at the Drumlummon Mill during the period from 1875 to 1900, although no records are available.

A mill was constructed in the mid 1970s east of Marysville by John White reportedly for the purpose of reprocessing mill tailings material. Operations at this mill were shut down in 1976 following reports of a fish kill in Silver Creek and an investigation by the Montana Department of Fish, Wildlife, and Parks (MDFWP). The mill was purchased in the late 1970s by Goldsil Ranchers Company and reportedly operated for a short time during the summer of 1980 until a fire and another reported seepage from the lower tailings pond caused mill operations to cease. The following timeline was constructed by Maxim Technologies, Inc. (DEQ-AMRB/Maxim,1996) from DEQ Water Quality Bureau files:

Mid 1970s	White Mill Constructed
February 1976	Fish kill reported below mill
October 1976	High cyanide and metals concentrations measured in a mill pond, low cyanide and metals concentrations measured in Silver Creek by MDFWP during investigation of fish kills
September 1980	>68 dead fish counted by WQB below mill
September 1981	Consent Decree, District Court, Goldsil fined $5,000 and pays $4,755 agency costs
January 5, 1983	Hydrometrics investigation of mercury and cyanide in Silver Creek completed
October 31, 1983	Release of water to Silver Creek from new pond upstream of mill reported
February 31, 1984	Goldsil submits mine permit application to Department of State Lands
July 7, 1984	Goldsil submits response to comments to Department of State Lands
March 7-19, 1986	Tailings pond at mill in danger of overflowing, pumped down
July 9, 1986	Dead cows reported near mill, mill fenced off to cows

Currently the mill building is torn down and no mining or milling activities are known to be active in the drainage basin.

2.2 CLIMATE

There are no official weather stations in the Silver Creek drainage. There are two weather stations within generally an 8-mile radius around the Silver Creek drainage. National Oceanic and Atmospheric Administration's Western Regional Climate Center has compiled temperature and precipitation data at Canyon Creek (241450), Montana and Austin (240375), Montana for the periods May 6, 1907 through March 31, 1979 and April 12, 1950 through December 31, 2001, respectively. These appear to be the closest official weather stations to the Silver Creek drainage. Canyon Creek and Austin are approximately 4 miles northeast and 8 miles south of Marysville, respectively. The average annual maximum and minimum temperatures recorded at the Austin site were 53.6 degrees Fahrenheit (°F) and 29.6° F. Temperature data were not reported for the Canyon Creek site. The average annual total precipitation for the Canyon Creek and Austin sites is 10.82 and 16.15 inches, respectively. The lowest and highest average precipitation occurs in the months of February/March and May/June, respectively. Average annual total snowfall is 43.2 inches and 59.9 inches for Canyon Creek and Austin, respectively. Most snow falls from December through April.

Like most of southwestern Montana, the Silver Creek drainage is subject to a cool and dry continental-dominated climate. The temperature of the region is marked by wide seasonal and daily variations. During winter, the temperature can fall lower than 30 degrees below zero Fahrenheit (°F). During summer, many days reach the 80's and 90's but due to the generally arid climate and lightness of the mountain air, the temperature can drop substantially at nightfall. Precipitation in the basin averages 30 inches annually at Marysville (U.S. Soil Conservation Service, 1974). Approximately half of the annual precipitation falls as snow during winter (90 inches average annual snowfall). Stormy weather usually brings the first snow during September, however, these "equinoctial storms" are generally succeeded by several weeks of fair weather. By November, the area is usually blanketed with snow. Heavy snows are frequent in the winter as are periods of melting and freezing which occur as a result of warm Chinook winds that occasionally blow from the west. The snowpack generally remains in the area for six months or longer, with spring thaw occurring in April or May (NOAA, 1988).

The area is subject to a distinct spring/summer rainy season with May or June usually being the wettest month of the year. On average, May and June each receive 3.5 inches of precipitation. The frost-free period (32° F or more) averages approximately 70 days annually, from mid-June to late August (NOAA, 1988).

2.3 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

2.3.1 Local and Regional Geology

A significant portion of the Silver Creek Drainage Project is located within the general area of the Marysville mining district, located near the continental divide in Lewis & Clark County. The stratigraphy of the area comprises units of the Precambrian Belt Supergroup, hosting a contact metamorphic zone surrounding a series of Cretaceous and Tertiary intrusives. Structurally, the Marysville mining district is located near the eastern terminus of the Lewis and Clark line, a zone of east-west trending, right lateral strike-slip faults which appear to have been intermittently active since middle Proterozoic with an active stage between 82 and 45 million years ago (Ma) (Walker, 1992). The major evidence of this faulting in the Marysville area is a series of faults near Bald Butte. Additional structure in the area is represented by a slight doming of the metasedimentary units around the major intrusive body.

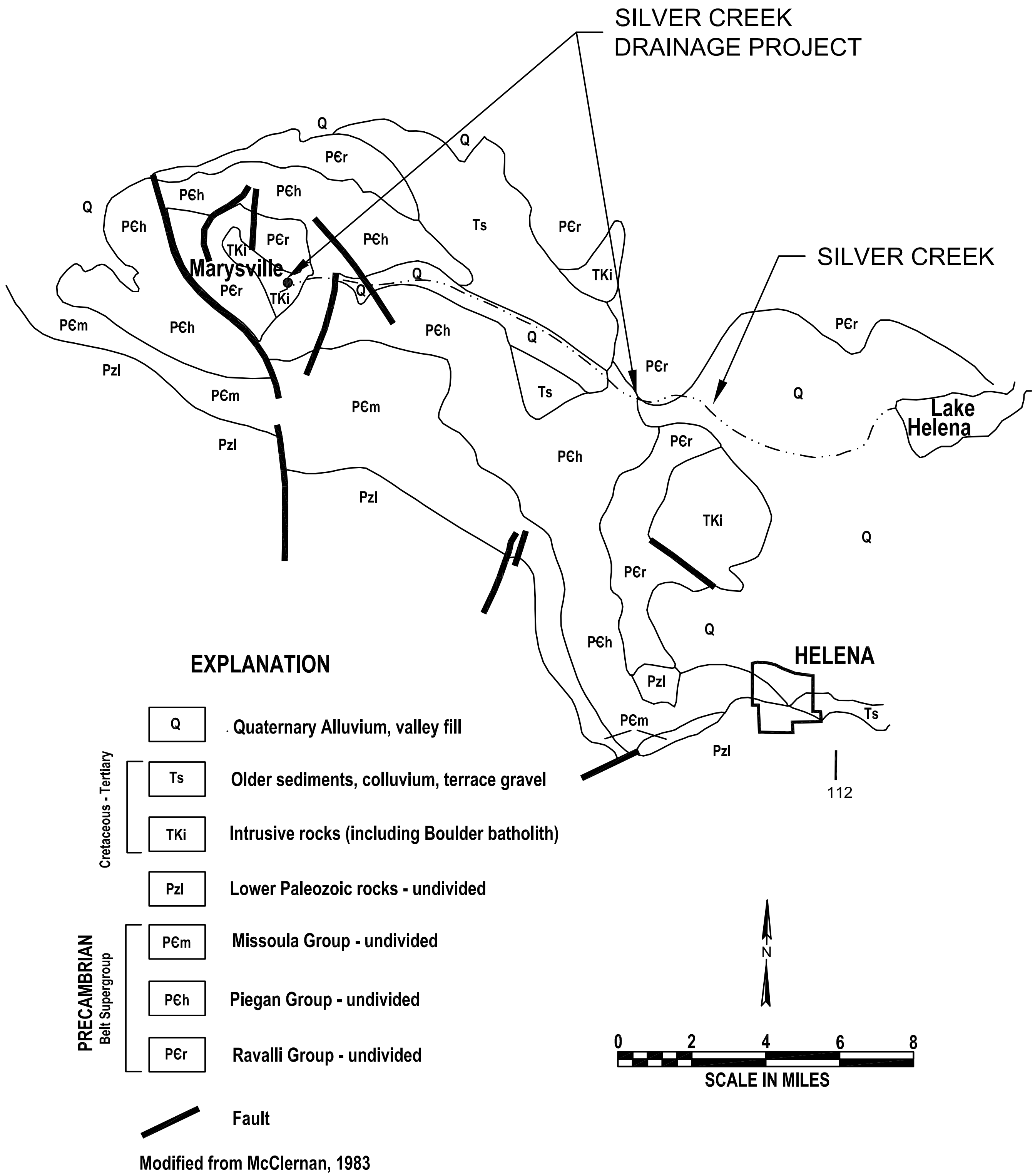
A generalized geologic map for the Silver Creek drainage area is presented in Figure 2-1. The stratigraphy of the major units in the area is summarized from Walker (1992). The two principal Precambrian units in the area are the Empire and Helena Formations (Knopf, 1913). The oldest formation exposed is the Empire Formation (Ravalli Group), characterized as a compact, locally calcareous, light to dark, greenish gray shale. Near Marysville, the shales have been metamorphosed to a fine-grained, light to dark green, gray or black hornfels banded green and purple. Overlying the Empire Formation hornfels is the Helena Formation (Piegan Group), generally a siliceous limestone, with some dolomite also present.

The oldest igneous rocks present are probably Precambrian microdiorite sills randomly distributed within the Empire and Helena Formations throughout the area. The sills are generally dark brown to black, less than three feet thick and often appear as swarms with multiple bands emplaced along bedding. The primary igneous unit, which forms the Marysville Stock, is a quartz diorite intruded at approximately 79 Ma. The surface exposure of the unit is irregular, with the main body located near the town of Marysville with an elongate extension to the Gloster mine area. A series of three porphyries of intermediate composition, and two hornblende diorite dikes, are also present within the western portion of the Marysville Mining district. At approximately 49 Ma, a rhyolite quartz porphyry intrusion occurred in the Bald Butte area, which was later intruded by a series of quartz porphyry sills and dikes between 37 to 40 Ma. The youngest igneous event in the mining district is a Tertiary rhyolite extrusive, dated at 37 Ma., occurring in limited exposures in the southwest portion of the Marysville mining district.

The Marysville mining district economic mineral deposits were contained in both placer and lode deposits. The gold and silver placer deposits are contained within unconsolidated alluvium in and around Silver Creek. Although gold and silver were the primary commodities in the lode deposits, lesser base metals including lead, zinc and copper were also produced. Gold occurred mostly as free gold, although there may have been some gold associated with pyrite at the Drumlummon and Gloster mines. Silver was associated with the gold and also occurred in other mineral phases including acanthite, tetrahedrite, and pearceite. The epigenetic and epithermal precious metal deposits occur in vein deposits hosted within the metasedimentary rocks near the contact zone with the quartz diorite of the Marysville stock. The veins are composed of varying amounts of quartz, carbonate and adularia gangue along with precious metals. The mining history indicates that sulfides typically increased with depth in the vein systems and sulfides included one or more of the following minerals: pyrite, chalcopyrite, galena and sphalerite. In areas known to have younger silicic intrustives at depth (i.e., Bald Butte and Empire Creek) veins are known to contain fluorite and molybdenite in addition to the normal epithermal mineral suite. Hydrothermal alteration differs on veins throughout the district. Alteration types include minor bleaching and kaolinization, silicification, and potassic alteration manifested by the intense development of biotite and orthoclase.

2.3.2 Hydrogeology

Hydrogeologic information specific to the Silver Creek area include a permit application for Goldsil Mining and Milling, Inc. prepared by Hydrometrics and submitted to the Montana



Olympus Technical Services, Inc.

GENERALIZED GEOLOGIC MAP
SILVER CREEK DRAINAGE PROJECT
Lewis & Clark County, Montana

FIGURE
2-1

Department of State Lands in 1984 (Goldsil Mining and Milling, 1984a). The following general observations on the hydrogeologic setting are based on information in this application as well as accepted hydrologic and geologic principles and local observations.

The Silver Creek drainage basin is comprised of a headwaters area near the town of Marysville and several major tributaries flowing from the south. The hydrogeologic system contains two main components; bedrock and alluvial valley fill. The bedrock is moderately fractured and contains vein structures associated with the intrusion of the stock. Numerous fractures are present in the bedrock, including bedding structures, joints and faults associated with the tectonic history, and vein structures. The dolomite of the Helena Formation could also contain secondary groundwater flow pathways due to solution of the dolomite by groundwater. Due to the complex and unpredictable nature of the bedrock structures, it is likely that the rate and direction of groundwater flow is widely variable over short distances. Permeability and transmissivity of the bedrock aquifer system probably vary widely. The alluvial deposits are thin, shallow, and discontinuous and likely transmit both surface water from local streams and discharging bedrock groundwater.

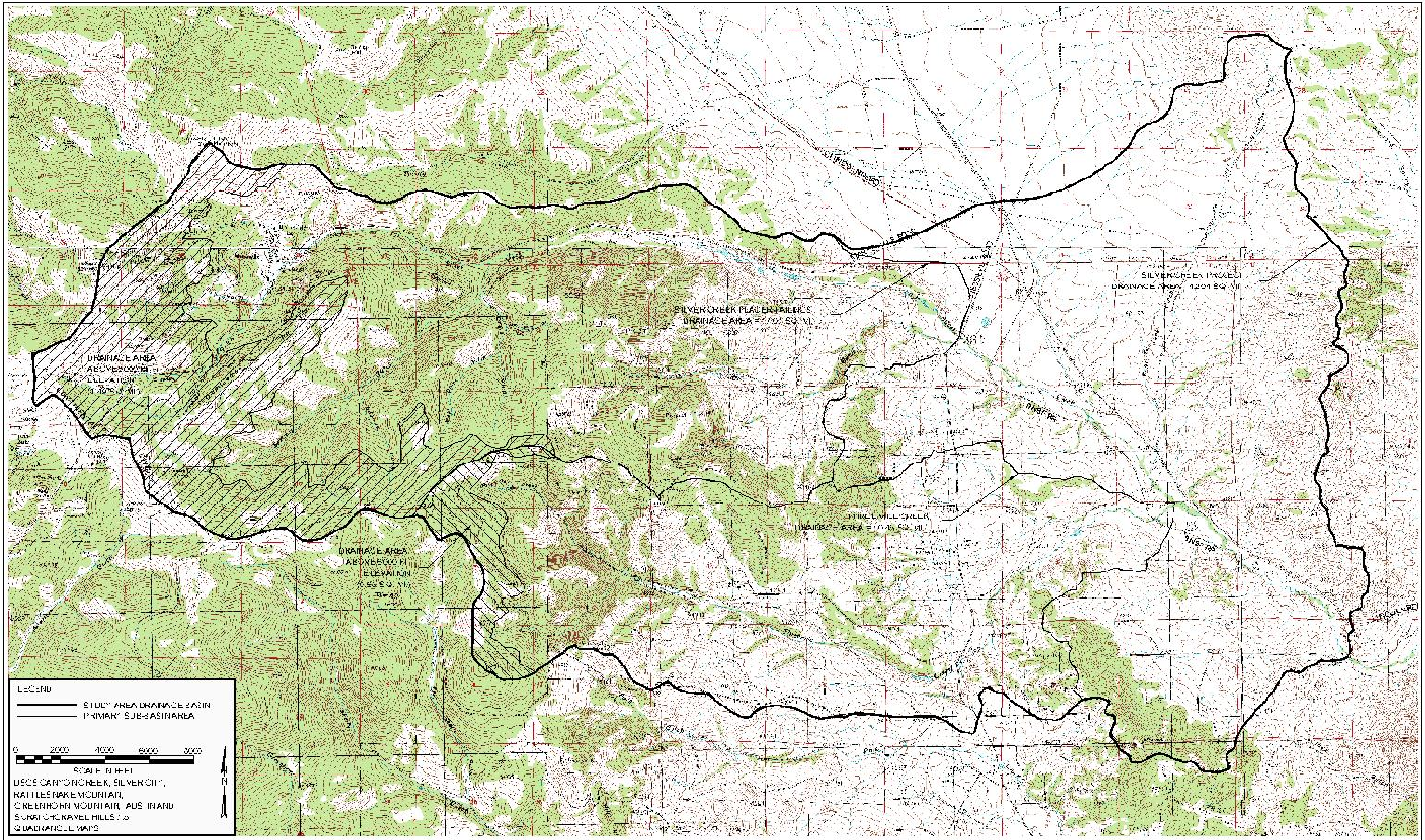
Groundwater flow likely follows local stream gradients and topography, with groundwater discharging to gaining alluvial streams which is typical of high mountain drainage systems. However, local bedrock fault systems and secondary solution features probably exert significant control on the direction and rate of groundwater flow, as do the underground workings associated with the mines in the area.

2.3.3 Surface Water Hydrology

Surface hydrology in the Silver Creek drainage basin consists of Silver Creek and several perennial and intermittent gulches. Figure 2-2 shows the drainage area of the Silver Creek Drainage Project. In the upper reaches, Silver Creek is formed by the confluence of surface water flow from Ottawa and Rawhide gulches above the town of Marysville. Jennies Fork, which drains the area northwest of Marysville, enters Silver Creek from the north immediately downstream of Marysville. Other major tributaries to Silver Creek downstream from Marysville include Sawmill Gulch, Sitzer Gulch, and Threemile Creek, all entering from the south (Figure 2-2). No significant mining activity is known to have been performed in any of these three tributary drainages.

Contributions to surface water flow in the headwaters of Silver Creek also include the discharges from several abandoned mines. Adit discharges have been documented from the Shannon Mine, Bald Mountain Mine, Belmont Mine, and the Drumlummon Mine (DEQ-AMRB/Maxim, 1996). Discharges from abandoned adits associated with the Bald Mountain and Belmont mine were sampled during the spring of 1996 prior to reclamation work on these discharges (DEQ-AMRB/Maxim, 1996).

The hydrology of the headwaters area of Silver Creek above Marysville has been slightly affected by mine adits and by mine waste rock piles. Severe effects to the stream hydrology by placer mining and deposition of mill wastes are present from Marysville to the Birdseye road. The majority of the valley bottom and flood plain in this lower reach has been placer mined and several mill tailings ponds are located in the floodplain. A tailings dam associated with the Drumlummon Mill is located in the Silver Creek approximately 1.5 miles downstream from Marysville. This tailings dam failed during high flows which occurred in the spring of 1992 and



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			APPROVED:	DATE: 5/2002	JOB NO: A1234			FIGURE 2-2
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was repaired by a Water Quality Bureau contractor in 1994 by placing riprap along two channels which convey Silver Creek through the breached dam. Several other tailings dams and ponds have been constructed in old placer tailings material downstream of the breached tailings dam. These ponds are located in dredge tailings on the south bank of Silver Creek and were associated with a mill constructed by John White in the 1970s. This mill was also operated by the Goldsil Mining Company during the 1980s.

There are no records for stream gaging stations on Silver Creek. A gaging station was operated on Little Prickly Pear Creek near Marysville from 1913 through 1932. Little Prickly Pear Creek is the drainage directly north of Marysville. The gaging station has a reported drainage area of 44.40 square miles and a gage datum of 4,700 feet above sea level. Omang (1992) reports flood frequency data at the Little Prickly Pear gaging station based on the data for the period of record as shown in Table 2-1.

TABLE 2-1 PEAK DISCHARGE FOR LITTLE PRICKLY PEAR CREEK NEAR MARYSVILLE (OMANG, 1992)

Recurrence Interval (years)	Peak Discharge (cfs)
2	141
5	255
10	354
25	510
50	650
100	813

A procedure developed by Omang (1992) that uses the drainage-area ratio of an ungaged site to that of a gaged site was used to estimate the magnitude and frequency of floods for the Silver Creek drainage for the project area. This method is valid for drainage areas that are between 0.5 and 1.5 times the area of the gaged drainage area. The Silver Creek Drainage Project covers an area of 42.04 square miles, which is 94.7 percent of the gaged drainage area. The peak discharges for the Silver Creek drainage estimated by drainage-area ratios are shown in Table 2-2.

Peak discharge for Silver Creek was also estimated using regional flood-frequency equations developed by Omang (1992). The regional equations for southwest Montana use the drainage basin area (42.04 square miles) and the percentage of the basin area above 6,000 feet in elevation (12.3 percent) to estimate peak discharge. Peak discharges estimated by regional flood-frequency equations for the Silver Creek drainage are shown in Table 2-2.

TABLE 2-2 ESTIMATES OF PEAK DISCHARGE FOR THE SILVER CREEK DRAINAGE PROJECT AREA

Recurrence Interval (years)	Peak Discharge (cfs) by Drainage-Area Ratio	Peak Discharge (cfs) by Regional Flood-Frequency Equations
2	135	116
5	244	324
10	339	557
25	490	958
50	626	1389
100	783	1942

The known waste sources are all located upstream of Birdseye Road. The peak discharges for this upper portion of the Silver Creek basin were estimated using the regional flood-frequency equations. Peak discharges for the Silver Creek drainage upstream of Birdseye Road were estimated by regional flood-frequency equations (drainage area of 17.07 square miles and 26.3 percent of the basin above 6,000 feet in elevation) and are presented in Table 2-3.

TABLE 2-3 ESTIMATES OF PEAK DISCHARGE FOR THE SILVER CREEK DRAINAGE ABOVE BIRDSEYE ROAD

Recurrence Interval (years)	Peak Discharge (cfs) by Regional Flood-Frequency Equations
2	58
5	143
10	236
25	394
50	546
100	734

2.4 CURRENT SITE SETTING

2.4.1 Location and Topography

The Silver Creek drainage basin is located in Townships 11 and 12 North, Ranges 4, 5 and 6 West, in Lewis and Clark County on public and private land. The latitude of the basin is between North 46° 40' and 46° 50' and the longitude is between West 112° 00' and West 112° 21'. Silver Creek is formed by the confluence of streams flowing from Rawhide and Ottawa Gulches near the town of Marysville. From Marysville, Silver Creek flows eastward for approximately 16 air miles, crossing the northern portion of the Helena Valley before it enters Lake Helena. Due to irrigation diversions and other withdrawals, Silver Creek is intermittent in its lower reaches and does not reach the lake. Lake Helena is connected to Hauser Lake on the Missouri River.

The highest point in the Silver Creek drainage basin is Mount Belmont at an elevation of 7,331 feet above sea level. The topography of the basin is mountainous and is mostly forested. The terrain surrounding the mines in the headwaters of the drainage basin is generally rugged, consisting of relatively steep slopes (15 to 20 degrees). The land is used for wildlife habitat, livestock grazing, and recreation. The western boundary of the drainage basin is formed by the Continental Divide.

2.4.2 Vegetation/Wildlife

The area in the upper portions of the Silver Creek drainage above the town of Marysville is mostly continuously timbered with Lodgepole pine, Douglas fir, Engelmann spruce, and some Ponderosa pine. The area is important habitat for a variety of big game animals (mule deer, elk, moose, black bear), fur bearers (beaver and bobcat), waterfowl and birds. The area in the lower portions of the drainage is characterized by juniper, sagebrush, and native grasses.

Recreation in the drainage includes hunting and fishing. Silver Creek was reported as a good quality fishery with numerous trout being counted in the upper portion of the creek during a fish survey (Montana Department of Fish and Game, 1977). The lower section of the creek had been reported as a good quality fishery, however no trout were found in the lower section during the fish survey possibly due to a fish kill.

The MDFWP fisheries information contained in the Montana Rivers Information System (MRIS) database (MRIS, 2002) indicates that Silver Creek is 21.6 miles long and has a Fisheries Resource Values (FRV) of 4 for both habitat class and sport class, with a final value of moderate.

According to the MRIS database, Brook Trout are year-round residents and are considered present in abundance. Westslope Cutthroat Trout are year-round residents and are considered common in abundance. Brown Trout, Kokanee and Rainbow Trout are residents and use this stream reach for spawning, but are uncommon in abundance. Silver Creek is posted by MDFWP as catch and release only because of elevated mercury concentrations in fish tissue; however, this is not reported in the MRIS database.

2.4.3 Historic or Archaeologically Significant Features

(To be completed upon receipt of the Cultural Resources Inventory from DEQ)

2.4.4 Land Use and Population

The small community of Marysville is located on Silver Creek near its headwaters. An estimated 50 residents live year-round at Marysville, and approximately 10 additional cabins are located in the vicinity of the townsite for recreational/seasonal use. Recreational land use near Marysville includes hunting, fishing, camping, hiking, 4-wheeling, mountain biking, snowmobiling, and skiing. The Great Divide Ski Area is located at the base of Mt. Belmont and experiences approximately 30,000 to 40,000 skier days per year (Maxim, 1995).

2.5 PREVIOUS WORK

Previous sampling has been conducted by several parties in the Silver Creek area. Most of these studies have focused on the Goldsil millsite and tailings area. The following is a summary of the known sampling that has been completed:

- Maxim Technologies, Inc. completed a hydrologic baseline investigation of the Silver Creek drainage basin in 1996 for the DEQ-AMRB (DEQ-AMRB/Maxim 1996). The study included surface water and point source discharge sampling, groundwater and stream sediment sampling.

- MDFWP and Montana Department of Health and Environmental Sciences (MDHES) completed a lake and selected stream water quality assessment and contaminant monitoring of fish and sediments from Montana waters in 1994 (MDFWP/MDHES, 1994). The highest concentrations of mercury observed in fish were from Silver Creek. No sediment samples were collected from Silver Creek.

- Pioneer Technical Services, Inc. (Pioneer) completed Hazardous Material Site Inventories for the Montana Department of State Lands, Abandoned Mine Reclamation Bureau (MDSL/AMRB) at the Bald Mountain Mine (MDSL/AMRB, 1993a), Belmont Mine (MDSL/AMRB, 1993b), Goldsil millsite (MDSL/AMRB, 1993c) and Drumlummon Mine, Mill and Tailings (MDSL/AMRB, 1994). These inventories included surface water, stream sediment, waste, and background soil sampling, as well as assessments of other physical hazards.

- Roy F. Weston, Inc. collected samples from surface water, stream sediments, surface impoundments, pond sumps/seeps, soil and wastes in the Goldsil area for the MDHES (1988).

- An operating permit and reclamation plan was prepared for Goldsil Mining and Milling, Inc. by Hydrometrics, Inc. (Goldsil Mining and Milling, Inc., 1984a and 1984b). The permit application was for the mining of two small open pits and selected waste rock and tailings deposits near the Drumlummon mine. Data presented in the application included an inventory of wells and springs in the Marysville area, and the collection of surface water and groundwater samples.

- The MDFWP collected samples of fish tissue and found mercury concentrations exceeding the recommended concentration established by the Food and Drug Administration (MDFWP, 1984). Silver Creek was subsequently restricted to catch and release only.

- Hydrometrics, Inc. (1983) collected water samples on behalf of Goldsil Mining and Milling, Inc. in response to a consent decree regarding alleged mercury contamination of Silver Creek and an alleged violation of water quality standards caused by seepage from the Goldsil Mining and Milling tailings pond.

- A study by the Montana Department of Fish and Game (1977) documented the seepage of water containing metals and cyanide from tailings ponds at the White (now Goldsil) mill. The report documents a decrease in macro-invertebrates and fish from above the tailings ponds to below the ponds. A fish kill reported on February 3, 1976 was suspected to have been caused by a release from the tailings ponds.

2.5.1 Stream Sediment

Stream sediment samples were collected during previous investigations from 23 different locations in the Silver Creek drainage basin. The results of these samples are presented in Table 2-4. Summary statistics from these samples (sediment only) are presented in Table 2-5. The previous stream sediment results are compared to data from the Silver Creek Drainage Project in the Phase I Reconnaissance Site Characterization Report (DEQ-MWCB/Olympus, 2003).

2.5.2 Waste Sources

Tailings samples were collected during previous investigations from 15 different locations in the Silver Creek drainage basin. These locations included samples from the Bald Mountain, Belmont, Drumlummon and Goldsil mine and millsite areas. The results of these samples are

Table 2-4. Summary of Previous Silver Creek Drainage Stream Sediment and Mine/Mill Waste Sampling Results

Sample Station	Sample Date	Sample Location	Medium	Ag (mg/Kg)	Al (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Be (mg/Kg)	Cd (mg/Kg)	Co (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Bulk Sediment Hg (mg/Kg)	Fine Sediment Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Se (mg/Kg)	Zn (mg/Kg)	Total Cyanide (mg/Kg)	Source/Date
25-200-SW-01	10/11/95	Rawhide Gulch	Sediment	7	10500	15.0	110		3.0		15	37	16400	0.5	1.7	460	15	20		5	48		Maxim, 1996
25-200-SW-01	08/01/96	Rawhide Gulch	Sediment	6	23000	33.0	190		6.0		14	30	26700			1190	18	70		4	123		Maxim, 1996
25-200-SW-02	10/11/95	Marysville	Sediment	7	9340	13.0	110		4.4		11	22	19300	2.2	7.7	494	15	59		5	74		Maxim, 1996
25-200-SW-02	08/01/96	Marysville	Sediment	10	27900	35.0	240		5.9		15	50	27200			920	15	230		4	165		Maxim, 1996
25-200-SW-02	08/01/96	Marysville	Sediment	10	26600	31.0	240		6.2		15	47	26400			860	16	220		4	163		Maxim, 1996
25-200-SW-03	10/11/95	Jennies Fork at mouth	Sediment	18	7540	22.0	70		3.7		7	74	18300			1930	15	96		5	173		Maxim, 1996
25-200-SW-03	08/01/96	Jennies Fork at mouth	Sediment	30	18500	28.0	120		6.6		13	90	27400			1510	15	190		4	296		Maxim, 1996
25-200-SW-04	10/11/95	Below Drumlummon	Sediment	18	9400	17.0	110		4.0		11	73	17900	3.9	13	1910	15	114		5	202		Maxim, 1996
25-200-SW-04	08/01/96	Below Drumlummon	Sediment	19	21800	29.0	170		6.0		15	79	23700			1390	15	150		4	207		Maxim, 1996
25-200-SW-05	10/11/95	Sawmill Gulch at mouth	Sediment	7	17800	20.0	150		3.0		11	15	16700			316	15	20		5	48		Maxim, 1996
25-200-SW-05	08/01/96	Sawmill Gulch at mouth	Sediment	15	7090	11.0	70		2.6		11	26	9250			731	11	37		5	82		Maxim, 1996
25-200-SW-06	10/11/95	Breached Tailings Dam	Sediment	19	26600	18.0	150		5.4		18	61	21900	0.7	9.9	860	13	190		4	166		Maxim, 1996
25-200-SW-06	08/01/96	Breached Tailings Dam	Sediment	15	8240	33.0	70		3.7		7	44	16000			453	11	37		5	145		Maxim, 1996
25-200-SW-07	10/11/95	Goldsil Millsite	Sediment	11	8210	41.0	70		4.4		7	37	17000	4.6	20	438	11	37		5	96		Maxim, 1996
25-200-SW-07	10/11/95	Goldsil Millsite	Sediment	26	18000	42.0	150		6.8		15	103	25600			1320	15	160		4	216		Maxim, 1996
25-200-SW-07	08/01/96	Goldsil Millsite	Sediment	7	15600	16.0	220		3.3		11	33	12200			99	18	20		5	48		Maxim, 1996
25-200-SW-08	10/11/95	Sitzer Gulch at Birdseye Rd.	Sediment	15	9330	85.0	110		4.4		7	40	18500			849	15	20		5	113		Maxim, 1996
25-200-SW-09	10/11/95	Birdseye Rd.	Sediment	15	18600	60.0	290		6.9		14	90	29800	5	20	3510	18	150		4	139		Maxim, 1996
25-200-SW-09	08/01/96	Birdseye Rd.	Sediment	7	11800	20.0	330		4.4		15	15	17300			775	18	20		5	77		Maxim, 1996
25-200-SW-11	10/11/95	Silver Creek Estates Rd.	Sediment	18	7320	8.7	90		3.3		7	47	11200	8.8	2.4	468	11	25		5	102		Maxim, 1996
25-200-SW-11	08/01/96	Silver Creek Estates Rd.	Sediment	16	16000	11.0	200		3.3		12	66	16200			1400	17	80		4	160		Maxim, 1996
SW-10	10/11/95	Threemile Creek at Birdseye Rd.	Sediment											0.5									Maxim, 1996
25-167-TP-1	08/19/93	Belmont Mine	Tailings			28	30.2		1.0	1.61	2.87	56.8	6510	1.93		1190	2.38	48.4	10		230	NR	MDSL/AMRB, 1993a
25-167-TP-2	08/19/93	Belmont Mine	Tailings			32.2	36.2		0.7	1.85	2.61	38.1	6840	0.464		1520	3.54	38.1	5.74		208	<0.277	MDSL/AMRB, 1993a
25-167-WR-1	08/19/93	Belmont Mine	Waste Rock			19	26.5		0.4	3.07	4.46	35.8	10700	0.723		630	5.27	14.6	4.97		65.6	NR	MDSL/AMRB, 1993a
25-061-TP-1	08/19/93	Bald Mountain Mine	Tailings			14.3	50.4		0.9	3.62	5.94	79.1	9450	0.523		2200	4.55	142	6.37		256	NR	MDSL/AMRB, 1993b
25-061-TP-2	08/19/93	Bald Mountain Mine	Tailings			16.5	117		1.0	3.68	3.73	56.4	9870	0.964		1810	4.72	84.5	9.83		158	NR	MDSL/AMRB, 1993b
25-061-WR-1	08/19/93	Bald Mountain Mine	Waste Rock			48.8	64.7		0.7	6.81	5.51	36.6	14200	0.324		994	7.37	41.7	4.7		125	NR	MDSL/AMRB, 1993b
25-024-SE-1	08/23/94	Drumlummon Mine	Sediment	1.9		30.5	148		0.8	6.1	13.9	38.8	16100	0.18		1050	7.7	203	6.2		196	NR	MDSL/AMRB, 1994
25-024-SE-2	08/23/94	Drumlummon Mine	Sediment	4.5		19.8	150		0.7	6.0	8.7	30.6	13100	6.20		490	6.4	62.0	7.4		73.7	NR	MDSL/AMRB, 1994
25-024-SE-3	08/23/94	Drumlummon Mine	Sediment	18.8		13.5	71.8		1.5	3.9	9.0	60.7	9120	3.78		742	4.9	77.7	5.4		123	NR	MDSL/AMRB, 1994
25-024-TP-1	08/23/94	Drumlummon Mine	Tailings	27.4		33.7	99.2		0.7	4.3	12.5	149	11100	1.94		744	8.0	112	16.1		257	0.401	MDSL/AMRB, 1994
25-024-TP-2	08/23/94	Drumlummon Mine	Tailings	27.4		35.1	61.3		0.7	3.0	10.2	116	9230	1.85		626	5.9	117	12.9		205	0.219	MDSL/AMRB, 1994
25-024-WR-1	08/23/94	Drumlummon Mine	Waste Rock	0.4		21.7	46.2		0.4	5.6	16.9	30.1	23300	0.41		491	9.8	12.1	4.3		59.6	NR	MDSL/AMRB, 1994
25-024-WR-2	08/23/94	Drumlummon Mine	Waste Rock	5		46.2	57.0		2.8	4.2	9.3	55.3	13200	1.43		727	6.1	119	5.7		311	NR	MDSL/AMRB, 1994
25-365-SE-1	09/02/93	Goldsil Millsite	Sediment			66.6	83.3		1.0	4.26	5.27	31.8	11400	0.69		787	6.22	16.2	7		62.4	NR	MDSL/AMRB, 1993c
25-365-SE-2	09/02/93	Goldsil Millsite	Sediment			34.2	94		1.0	1.39	3.85	23.2	6400	3.11		480	3.14	12.2	7.06		64.1	NR	MDSL/AMRB, 1993c
25-365-TP-1	09/02/93	Goldsil Millsite	Tailings			41.2	51.7		2.0	2.35	6.07	197	8470	81.4		884	3.4	237	10.8		470	2.57	MDSL/AMRB, 1993c
25-365-TP-2	09/02/93	Goldsil Millsite	Tailings			37.1	52.5		2.0	1.97	4.92	187	7620	46.4		843	3.43	207	11.1		400	2.4	MDSL/AMRB, 1993c
25-365-TP-3	09/02/93	Goldsil Millsite	Tailings			13	58.6		1.0	3.48	6.54	53.1	8480	5.42		852	3.82	68.5	7.08		137	0.379	MDSL/AMRB, 1993c
25-365-TP-4	09/02/93	Goldsil Millsite	Tailings			34.9	74.8		2.0	4.9	18.6	198	11700	21.4		827	13	245	31.2		477	3.13	MDSL/AMRB, 1993c
25-365-TP-5	09/02/93	Goldsil Millsite	Tailings			84.5	117		3.5	5.96	15.3	379	18600	223		1430	14	537	66.9		1010	1.97	MDSL/AMRB, 1993c
25-365-TP-6	09/02/93	Goldsil Millsite	Tailings			36.6	59.9		3.4	4.35	7.86	160	9210	86		857	8.39	205	30.3		412	2.82	MDSL/AMRB, 1993c
SW-1-sed	Sep-88	3 mi. west of downstream entrance	Sediment											3.40									MDHES, 1988
SW-2-sed	Sep-88	0.9 mi west of downstream entance	Sediment											3.50									MDHES, 1988
SW-3-sed	Sep-88	At upstream entrance	Sediment	7.0	8160	69	59	1.5	1.0		7.0	84	12900	14		527		30			162		MDHES, 1988
SW-4-sed	Sep-88	Corner of upper lagoon	Sediment											28									MDHES, 1988
SW-5-sed	Sep-88	At downstream entrance (SW--07)	Sediment	15.1	5490	76	41		2.3		8.5	33	12900	4.0		681		10.7			87	28	MDHES, 1988
SW-6-sed	Sep-88	Just downstream from lower lagoon	Sediment											9.2									MDHES, 1988
SW-7-sed	Sep-88	Just downstream from Buck Lake	Sediment											33									MDHES, 1988
UL-1-sed	Sep-88	Lagoon, upstream from mill	Tailings	39	2730	65	31	0.9	3.3		7.9	172	8020	24		666		35			292		MDHES, 1988
ML-1-sed	Sep-88	Lagoon, just north of mill	Tailings	5.7	8780	157	70	2.9	4.8		14.8	100	17800	78		739		157			565		MDHES, 1988
LL-1-sed	Sep-88	Lagoon, just upstream from Buck Lake	Tailings	2.3	3790	61	50	3.2	2.8		13.9	168	12100	34		969		96			363	28	MDHES, 1988
SS-1	Sep-88	Soil composite, storage shed	Soil											12.0									MDHES, 1988
SS-2	Sep-88	Soil composite, process vats	Soil											17.0								8.7	MDHES, 1988

TABLE 2-5 SUMMARY STATISTICS FOR PREVIOUS SEDIMENT SAMPLING

Analyte	Mean (mg/Kg)	Median (mg/Kg)	Maximum (mg/Kg)	No. Samples
Ag	13.20	15	30	26
Al	14470.4	11800	27900	23
As	32.08	28.5	85	28
Ba	139.5	115	330	28
Be	1.5	1.5	1.5	1
Cd	3.77	3.7	6.9	28
Co	4.33	4.26	6.1	5
Cr	10.97	11	18	28
Cu	49.33	42	103	28
Fe	17745.4	16850	29800	28
Bulk Sediment Hg	6.76	3.84	33	20
Fine Sediment Hg	10.67	9.9	20	7
Mn	951.43	781	3510	28
Ni	13.09	15	18	26
Pb	84.17	60.5	230	28
Sb	6.61	7	7.4	5
Se	4.57	5	5	21
Zn	128.97	123	296	28

presented in Table 2-4. Summary statistics for these tailings samples are presented in Table 2-6. These values are compared with the current study in Sections 6.2, 6.3, 6.4 and 6.5.

Waste rock samples were collected during previous investigations from 4 different locations in the Silver Creek drainage basin. These locations included samples from the Bald Mountain, Belmont and Drumlummon mine areas. The results of these samples are presented in Table 2-4. Summary statistics for waste rock samples are presented in Table 2-7.

Acid/base accounting data for tailings and waste rock samples from hazardous materials inventories for the Bald Mountain, Belmont, Drumlummon and Goldsil mines/millsites are summarized in Table 2-8.

2.5.3 Fish Tissue

Several investigations of the fishery and water quality in Silver Creek have been performed by State of Montana wildlife and health agencies. These include an evaluation of the causes of a fish kill in Silver Creek which occurred in September, 1976 (Montana Department of Fish and Game, 1977), a statewide water pollution study (MDFWP, 1984) and contaminant monitoring of fish and sediments (MDFWP, 1994). Concentrations of mercury as high as 4.3 mg/Kg in fish tissue have been measured. The U.S. Food and Drug Administration action level is 1.0 mg/Kg of mercury for fish. The fishery was made a catch and release only in 1983 by the Fish and Game Commission to protect human health. Fish tissue sample results are summarized in Table 2-9.

TABLE 2-6 SUMMARY STATISTICS FOR PREVIOUS TAILINGS SAMPLING

Analyte	Mean (mg/Kg)	Median (mg/Kg)	Maximum (mg/Kg)	No. Samples
Ag	20.36	27.4	39	5
Al	5100	3790	8780	3
As	46.01	35.1	157	15
Ba	63.99	58.6	117	15
Be	2.33	2.9	3.2	3
Cd	1.99	2	4.8	15
Co	3.42	3.55	5.96	12
Cr	8.92	7.86	18.6	15
Cu	140.6	149	379	15
Fe	10333.3	9230	18600	15
Hg	40.49	21.4	223	15
Mn	1077.1	857	2200	15
Ni	6.26	4.64	14	12
Pb	155.3	117	537	15
Sb	18.19	10.95	66.9	12
Zn	362.67	292	1010	15
Total Cyanide	4.65	2.4	28	9

TABLE 2-7 SUMMARY STATISTICS FOR PREVIOUS WASTE ROCK SAMPLING

Analyte	Mean (mg/Kg)	Median (mg/Kg)	Maximum (mg/Kg)	No. Samples
Ag	2.7	2.7	5	2
As	33.93	33.95	48.8	4
Ba	48.6	51.6	64.7	4
Cd	1.08	0.55	2.8	4
Co	4.92	4.9	6.81	4
Cr	9.04	7.41	16.9	4
Cu	39.45	36.2	55.3	4
Fe	15350	13700	23300	4
Hg	0.72	0.57	1.43	4
Mn	710.5	678.5	994	4
Ni	7.14	6.74	9.8	4
Pb	46.85	28.15	119	4
Sb	4.92	4.84	5.7	4
Zn	140.3	95.3	311	4

Table 2-8. Summary of Previous Silver Creek Drainage Acid/Base Accounting Results

Sample Station	Sample Date	Sample Location	Medium	Total Sulfur %	Total Sulfur Acid Base t/1000t	Neutral. Potent. t/1000t	Sulfur Acid Base Potent. t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	Pyritic Sulfur Acid Base t/1000t	Sulfur Acid Base Potent. t/1000t	Reference
25-365-TP-1	09/02/93	Goldsil Millsite	Tailings	0.03	0.94	84.1	83.1	0.01	<0.01	0.02	0	84.1	MDSL/AMRB, 1995c
25-365-TP-2	09/02/93	Goldsil Millsite	Tailings	<0.01	0	68.5	68.5	<0.01	0.02	0.02	0.62	67.8	MDSL/AMRB, 1995c
25-365-TP-3	09/02/93	Goldsil Millsite	Tailings	<0.01	0	49.9	49.9	<0.01	<0.01	<0.01	0	49.9	MDSL/AMRB, 1995c
25-365-TP-4	09/02/93	Goldsil Millsite	Tailings	<0.01	0	78.5	78.5	<0.01	<0.01	0.02	0	78.5	MDSL/AMRB, 1995c
25-365-TP-5	09/02/93	Goldsil Millsite	Tailings	0.05	1.56	124	122	0.01	0.01	0.03	0.31	123	MDSL/AMRB, 1995c
25-365-TP-6	09/02/93	Goldsil Millsite	Tailings	0.22	6.87	82.9	76.1	0.09	0.03	0.1	0.94	82	MDSL/AMRB, 1995c
25-024-TP1	6/23-24/93	Drumlummon	Tailings	0.01	0.31	72.6	72.3	<0.01	<0.01	0.01	0	72.6	MDSL/AMRB, 1995d
25-024-TP2	6/23-24/93	Drumlummon	Tailings	0.01	0.31	82.0	81.7	<0.01	<0.01	0.01	0	82.0	MDSL/AMRB, 1995d
25-024-WR1	6/23-24/93	Drumlummon	Waste Rock	0.04	1.25	153	152	<0.01	0.07	0.05	2.19	151	MDSL/AMRB, 1995d
25-024-WR2	6/23-24/93	Drumlummon	Waste Rock	0.15	4.69	91.3	86.6	0.07	0.03	0.05	0.94	90.4	MDSL/AMRB, 1995d
25-167-TP-1	08/19/93	Belmont	Tailings	<0.01	0	74.3	74.3	<0.01	<0.01	0.01	0	74.3	MDSL/AMRB, 1995b
25-167-TP-2	08/19/93	Belmont	Tailings	<0.01	0	74.4	74.4	<0.01	<0.01	<0.01	0	74.4	MDSL/AMRB, 1995b
25-167-WR-1	08/19/93	Belmont	Waste Rock	<0.01	0	96.8	96.8	<0.01	0.01	0.01	0.31	96.5	MDSL/AMRB, 1995b
25-061-TP-1	08/19/93	Bald Mountain	Tailings	0.07	2.19	38.7	36.6	0.03	0.01	0.03	0.31	38.4	MDSL/AMRB, 1995a
25-061-TP-2	08/19/93	Bald Mountain	Tailings	0.01	0.31	60.1	59.8	<0.01	0.01	0.01	0.31	59.8	MDSL/AMRB, 1995a
25-061-TP-2DUP	08/19/93	Bald Mountain	Tailings	<0.01	0	60.3	60.3	<0.01	0.01	0.01	0.31	60	MDSL/AMRB, 1995a
25-061-WR-1	08/19/93	Bald Mountain	Waste Rock	0.02	0.62	57.9	57.2	<0.01	<0.01	0.03	0	57.9	MDSL/AMRB, 1995a

Table 2-9. Summary of Silver Creek Drainage Fish Tissue Mercury Results

Fish Species	Sampling Date	Site Description	Size range (inches)	Number of Samples	Hg (ug/g)	Hg Concentration (ug/g wet weight) Mean	Range	Reference
Cutthroat trout	1992	not available	12.7	1	1.6			MWFP and MDHES, 1994
Cutthroat trout	1992	not available	17.1	1	3.1			MWFP and MDHES, 1994
Cutthroat trout	1992	not available	18.7	1	3.0			MWFP and MDHES, 1994
Cutthroat trout	June, 1983	above Buck Lake	5.8-17.0	6		1.68	0.38-4.30	MWFP, 1984
Cutthroat trout	June, 1983	near Chairman Gulch	5.4-9.9	5		0.38	0.29-0.52	MWFP, 1984

2.5.4 Surface Water

A total of 173 surface samples were collected during previous investigations from 74 reported location descriptions in the Silver Creek drainage basin. The sample results are presented in Table 2-10. The most comprehensive of the previous surface water sampling was completed by Maxim (DEQ-AMRB/Maxim, 1996). This is also the most current of the previous studies, and most representative of the current, post-active mining and milling conditions. Maxim collected surface water samples from 11 sample stations from October 1995 through August 1996. Water quality analytical data from surface water samples indicated that concentrations of several metals, arsenic, cyanide and total dissolved solids occasionally exceeded either Federal secondary water quality standards, Montana human health standards or Federal aquatic life standards. Aluminum concentrations (exceeding aquatic standards) along with iron and manganese (exceeding Montana human health standards) were the most common metals to exceed standards. Arsenic, cadmium, copper, lead, mercury, zinc and cyanide exceeded Montana and aquatic standards only occasionally. Total dissolved solids exceeded Federal drinking water secondary standards in three samples.

Surface water data collected by the MDHES, MDFWP and the Bureau of Land Management were reported in an operating permit application prepared by Goldsil Mining and Milling, Inc. (Goldsil Mining and Milling, Inc., 1984a and 1984b). Surface water was reported as excellent with the exception of detections of mercury occasionally reported. The water was classified as non-saline, very hard, calcium-bicarbonate type with low concentration of turbidity and metals. Except for mercury, the water would meet all federal water quality standards (DEQ-AMRB/Maxim, 1996).

2.5.5 Groundwater and Adit Discharges

Groundwater and adit discharge samples were collected during previous investigations in the Silver Creek drainage basin. A total of 38 samples have been collected from 27 different locations. Of these 38 samples, 24 were groundwater samples and 14 were adit discharge samples. The sample results are presented in Table 2-11.

Maxim (DEQ-AMRB/Maxim, 1996) collected groundwater samples from four wells in the Marysville area. These wells represent water quality in both the shallow alluvial aquifer and the deeper bedrock aquifer. Water quality samples contained low concentrations of dissolved minerals and metals. Two of the wells contained elevated concentrations of nutrients. All of the samples collected met federal drinking water Maximum Contaminant Level (MCL) and Secondary Maximum Contaminant Level (SMCL) standards.

An operating permit submitted to MDSL (Goldsil Mining and Milling, Inc., 1984a and 1984b) included an inventory of wells and springs in the Marysville area and chemical analyses of 13 groundwater sampling sites. Groundwater, mine discharge water and spring water quality was reported as high quality, very hard, calcium-bicarbonate type. With the exception of total iron and total and dissolved manganese, metals concentrations were very low and often less than laboratory detection limits. All of the analyses reported would meet Federal Primary Drinking Water Standards and would meet Federal Secondary Standards with iron and manganese removal.

Table 2-10. Summary of Silver Creek Drainage Surface Water Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Discharge (cfs)	Field pH (s.u.)	Lab pH (s.u.)	Field Specific Conductivity (umhos/cm)	Lab Specific Conductivity (umhos/cm)	Lab Turbidity (JTU)	Water Temp (C)	Oxidation Reduction Potential (mv)	Ag (ug/L) Total/Dissolved	Al (ug/L) Total/Dissolved	As (ug/L) Total/Dissolved	Ba (ug/L) Total/Dissolved	Cd (ug/L) Total/Dissolved	Co (ug/L)	Cr (ug/L) Total/Dissolved	Cu (ug/L) Total/Dissolved	Fe (ug/L) Total/Dissolved	Hg (ug/L) Total/Dissolved	Mn (ug/L) Total/Dissolved	Ni (ug/L) Total/Dissolved	Pb (ug/L) Total/Dissolved
		WQB-7-Human Health Standard	Surface Water									100		18	2000	5		100	1300	300	0.05	50	100	15
		WQB-7 Acute Aquatic Life Standard	Surface Water									13.4*	750	340		4.3*		NA**	26.9*		1.7		843.3*	197.3*
		WQB-7 Chronic Aquatic Life Standard	Surface Water										87	150		0.45*		NA**	16.9*	1000	0.91		93.8*	7.7*
Culvert Intake	03/27/02	Silver Crk Ranchette Rd.	Surface Water									ND		11	ND	ND		ND	20	1090	ND	120	ND	ND
Transfer Station Rd	03/27/02	Silver Crk - at Transfer Station Rd.	Surface Water									ND		5	ND	ND		ND	ND	ND	ND	ND	ND	ND
25-200-SW-01	10/11/95	Rawhide Gulch at Ski road	Surface Water	0.20	7.4	8.0	188	173		8.0	-240	50/50	200/200	1/1	200/200	.2/.2		10/10	1/1	80/50	.2/.2	15/15	2/2	1/1
25-200-SW-01	02/08/96	Rawhide Gulch at Ski road	Surface Water	0.02	6.7	7.3	186	160		6.0		50/50	300/200	1/1	200/200	.2/.2		10/10	5/5	280/50	.2/.2	15/15	2/2	1/1
25-200-SW-01	05/01/96	Rawhide Gulch at Ski road	Surface Water	0.28	6.8	8.2	224	170		4.0		50/50	200/200	1/1	200/200	.2/.2		10/10	5/5	50/50	.2/.2	15/15	2/2	1/1
25-200-SW-01	08/28/96	Rawhide Gulch at Ski road	Surface Water	0.13	7.0	7.8	162	180		10.0		50/50	500/200	2/2	200/200	2.9/1.4		10/10	2/2	510/80	.2/.2	60/23	2/2	40/30
25-200-SW-02	10/11/95	Silver Creek at Marysville	Surface Water	1.32	7.4	7.9	192	187		9.0		50/50	200/200	2/2	200/200	.2/.2		10/10	5/1	50/50	.2/.2	15/15	2/2	2/1
25-200-SW-02	02/08/96	Silver Creek at Marysville	Surface Water	0.46	7.6	7.4	228	234		7.0		50/50	200/200	2/2	200/200	.2/.2		10/10	5/5	290/50	.2/.2	25/15	2/2	3/1
25-200-SW-02	05/01/96	Silver Creek at Marysville	Surface Water	1.70	7.9	8.2	245	242		8.0		50/50	400/200	2/2	200/200	.2/.2		10/10	5/5	290/50	.2/.2	20/15	2/2	4/1
25-200-SW-02	08/28/96	Silver Creek at Marysville	Surface Water	1.22	6.2	7.9	233	267		12.0		50/50	900/200	2/2	200/200	.2/.2		10/10	4/2	80/18	.2/.2	56/49	2/2	9/4
25-200-SW-02A	08/28/96	Silver Creek immediately below Drumlummon waste rock pile	Surface Water		7.0	8.0	231	284		12.0		50/50	3200/200	5/1	200/200	5/1.6		10/10	6/3	2690/190	.2/.2	122/63	2/2	7/5
25-200-SW-03	10/11/95	Jennies Fork; at County Road	Surface Water	0.40	7.5	8.4	325	276		9.5		50/50	200/200	2/2	200/200	.2/.2		10/10	3/1	200/50	.2/.2	38/15	2/2	1/1
25-200-SW-03	02/08/96	Jennies Fork; at County Road	Surface Water	0.67	8.0	7.9	300	297		4.3		50/50	300/200	3/3	200/200	.2/.2		10/10	5/5	370/50	.2/.2	43/15	2/2	2/1
25-200-SW-03	05/01/96	Jennies Fork; at County Road	Surface Water	0.74	6.6	8.4	300	271		5.0		50/50	400/200	3/2	200/200	.2/.2		10/10	5/5	330/50	.2/.2	53/15	2/2	4/1
25-200-SW-04	10/11/95	Silver Creek at Skid Road (continuous recorder station)	Surface Water	1.53	7.2	8.2	232	276		10.0		50/50	200/200	2/2	200/200	.2/.2		10/10	3/1	80/50	.2/.2	18/15	2/2	1/1
25-200-SW-04	02/08/96	Silver Creek at Skid Road (continuous recorder station)	Surface Water	1.57	7.6	7.2	245	230		6.0		50/50	2700/200	7/2	200/200	.2/.2		10/10	18/5	2630/50	.2/.2	2940/15	2/2	18/1
25-200-SW-04	05/01/96	Silver Creek at Skid Road (continuous recorder station)	Surface Water	4.29	6.5	8.3	551	236		5.0		50/50	800/200	3/3	200/200	.2/.2		10/10	5/5	750/50	.2/.2	61/15	2/2	6/1
25-200-SW-04	08/28/96	Silver Creek at Skid Road (continuous recorder station)	Surface Water	1.75	6.8	8.2	250	293		12.0		50/50	500/200	2/2	200/200	6/6		10/10	3/2	590/100	.2/.2	520/31	2/2	4/2
25-200-SW-05	10/11/95	Sawmill Gulch	Surface Water	0.38	8.0	8.4	310	355		12.0		50/50	200/200	4/3	200/200	.2/.2		10/10	6/1	150/50	.2/.2	22/15	2/2	2/1
25-200-SW-05	02/08/96	Sawmill Gulch	Surface Water	0.75	7.9	7.4	354	298		6.0		50/50	700/200	5/2	200/200	.2/.2		10/10	5/5	510/50	.2/.2	28/15	2/2	1/1
25-200-SW-05	05/01/96	Sawmill Gulch	Surface Water	3.32	8.1	8.5	374	375		8.0		50/50	700/200	3/3	200/200	.2/.2		10/10	5/5	340/50	.2/.2	18/15	2/2	2/1
25-200-SW-06	10/11/95	Silver Creek immediately above reclaimed tailings channel	Surface Water	1.60	3.5	8.5	335	296		13.0		50/50	900/200	4/2	200/200	.2/.2		10/10	6/1	830/50	.4/.2	55/33	2/2	5/1
25-200-SW-06	02/08/96	Silver Creek immediately above reclaimed tailings channel	Surface Water	2.15	8.1	7.7	317	297		4.0		50/50	500/200	2/2	200/200	.2/.2		10/10	5/5	460/50	.2/.2	530/15	2/2	3/1
25-200-SW-06	05/01/96	Silver Creek immediately above reclaimed tailings channel	Surface Water	8.65	7.2	8.5	382	328		6.0		50/50	400/200	3/3	200/200	.2/.2		10/10	5/5	280/50	.2/.2	31/15	2/2	3/1
25-200-SW-06	08/28/96	Silver Creek immediately above reclaimed tailings channel	Surface Water	2.31	7.8	8.4	288	323		16.0		50/50	400/200	4/2	200/200	8/2		10/10	4/4	400/70	.2/.2	44/34	2/2	2/2
25-200-SW-07	10/11/95	Silver Creek at Goldsil, second culvert	Surface Water	1.23	7.6	8.3	328	395		11.0		50/50	200/200	8/8	200/200	.2/.2		10/10	3/1	160/50	.2/.2	31/29	2/2	1/1
25-200-SW-07	10/11/95	Duplicate 25-200-SW-07 (10/11/95)	Surface Water	1.23	7.6	8.1	328	395		11.0		50/50	200/200	8/8	200/200	.2/.2		10/10	1/1	140/50	.2/.2	32/29	2/2	1/1
25-200-SW-07	02/08/96	Silver Creek at Goldsil, second culvert	Surface Water	4.10	7.8	7.2	282	288		7.0		50/50	200/200	8/4	200/200	.2/.2		10/10	5/5	530/70	.2/.2	82/30	2/2	2/1
25-200-SW-07	05/01/96	Silver Creek at Goldsil, second culvert	Surface Water	9.48	8.1	8.5	357	350		8.0		50/50	200/200	5/4	200/200	.2/.2		10/10	5/5	80/50	.2/.2	21/17	2/2	1/1
25-200-SW-07	05/01/96	Duplicate 25-200-SW-07 (05/01/96)	Surface Water	9.48	8.1	8.5	357	347		8.0		50/50	200/200	8/3	200/200	.2/.2		10/10	5/5	90/50	.2/.2	22/16	2/2	1/1
25-200-SW-07	08/28/96	Silver Creek at Goldsil, second culvert	Surface Water	2.50	6.8	7.9	337	385		17.8		50/50	200/200	13/13	200/200	4/2		10/10	2/2	310/210	.2/.2	68/63	2/2	3/1
25-200-SW-08	10/11/95	Sitzer Gulch at Birdseye Road	Surface Water	0.13	6.5	8.2	810	792		14.0		50/50	200/200	8/3	200/200	.2/.2		10/10	1/1	100/50	.2/.2	73/73	2/2	1/1
25-200-SW-08	02/08/96	Sitzer Gulch at Birdseye Road	Surface Water	4.50	7.5	7.4	201	199		3.0		50/50	3500/200	4/3	200/200	.2/.2		10/10	14/5	3690/130	.2/.2	214/68	3/2	3/1
25-200-SW-08	05/01/96	Sitzer Gulch at Birdseye Road	Surface Water	0.30	8.0	8.2	703	726		9.0		50/50	200/200	10/4	200/200	.2/.2		10/10	5/5	120/50	.2/.2	53/46	2/2	1/1
25-200-SW-09	10/11/95	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water	0.92	7.7	8.4	422	424		13.0		50/50	200/200	13/13	200/200	.2/.2		10/10	2/1	90/50	.2/.2	15/15	2/2	1/1
25-200-SW-09	02/08/96	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water	65.00	7.8	7.4	202	198		4.0		50/50	1500/200	12/9	200/200	.2/.2		10/10	8/5	170/90	.2/.2	114/46	2/2	1/1
25-200-SW-09	05/01/96	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water	9.35	8.1	8.5	393	380		12.0		50/50	200/200	9/5	200/200	.2/.2		10/10	5/5	200/50	.2/.2	36/15	2/2	1/1
25-200-SW-09	08/28/96	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water	2.40	7.7	8.3	366	401		20.0		50/50	200/200	25/25	200/200	.2/.2		10/10	2/2	430/180	.2/.2	77/30	2/2	2/2
25-200-SW-10	10/11/95	Threemile Creek	Surface Water	0.13	7.1	8.3	432	385		13.0		50/50	200/200	24/20	200/200	.2/.2		10/10	6/1	80/50	.2/.2	15/15	2/2	1/1
25-200-SW-10	02/08/96	Threemile Creek	Surface Water	8.50	7.8	7.7	118	102		4.0		50/50	4200/200	14/14	200/200	.2/.2		10/10	8/5	3960/100	.2/.2	214/16	3/2	7/1
25-200-SW-10	05/01/96	Threemile Creek	Surface Water	1.00	8.1	8.4	432	366		7.0		50/50	300/200	14/7	200/200	.2/.2		10/10	5/5	290/50	.2/.2	39/16	2/2	2/1
25-200-SW-11	10/11/95	Silver Creek at Silver Creek Estates Road	Surface Water	1.31	8.0	8.3	825	776		13.0		50/50	200/200	12/8	200/200	.2/.2		10/10	5/3	190/50	.2/.2	82/72	2/2	1/1
25-200-SW-11	02/08/96	Silver Creek at Silver Creek Estates Road	Surface Water	45.00	7.4	7.2	160	178		4.0		50/50	2800/200	8/8	200/200	.3/.2		10/10	21/5	2930/160	.2/.2	3260/136	3/2	10/1
25-200-SW-11	02/08/96	Duplicate 25-200-SW-11 (02/08/96)	Surface Water	45.00	7.4	6.9	160	184		4.0		50/50	3900/200	8/8	200/200	.2/.2		10/10	27/5	3350/140	.2/.2	3580/13400	3/2	12/1
25-200-SW-11	05/01/96	Silver Creek at Silver Creek Estates Road	Surface Water	10.45	8.2	8.4	588	594		10.0		50/50	500/200	9/8	200/200	.2/.2		10/10	7/7	460/50	.2/.2	80/48	2/2	2/1
25-200-SW-11	08/28/96	Silver Creek at Silver Creek Estates Road	Surface Water	1.50	8.1	8.2	809	925		19.0		50/50	300/200	20/18	200/200	.5/.2		10/10	8/7	390/150	.2/.2	167/168	2/2	2/2
25-200-SW-11	08/28/96	Duplicate 25-200-SW-11 (08/28/96)	Surface Water			8.2		925				50/50	300/200	20/20	200/200	.2/.2		10/10	10/7	390/140	.2/.2	166/166	2/2	2/2
25-365-SW-1	09/02/93	Goldsil Millsite - at toe of berm w/flow gate in Silver Crk	Surface Water											5.29	82.7	4.59	5	6.24	2.33	123	0.12	21.8	10.9	1.13
25-365-SW-2	09/02/93	Goldsil Millsite - Silver Crk at culvert (downgradient) at rd.	Surface Water											4.35	73.6	4.59	5	6.24	2.33	90.8	0.12	15.3	10.9	1.69
25-365-SW-3	09/02/93	Goldsil Millsite - Silver Crk upgradient (200') from Argo mill bldg.	Surface Water											2.56	68.4	4.59	5	6.24	2.33	93.3	0.12	16.9	10.9	1.53
25-365-SW-5	09/02/93	Goldsil Millsite - pregnant pond below mill	Surface Water																					
25-024-AD1	6/23-24/93	Drumlummon - Adit discharge on WR4	Surface Water									0.14		34.9	128	2.6	8.7	4.7	4.6	2140	0.11	1640	8.0	2.1
25-024-SW1	6/23-24/93	Drumlummon - Ottawa Gulch (Silver Crk) upstream of mines and mills	Surface Water									0.12		2.2	94	2.6	8.7	4.9	4.6	44.1	0.11	8.0	9.8	2.9
25-024-SW2	6/23-24/93	Drumlummon - Silver Crk below mines, mills and TP1	Surface Water									0.12		2.1	81.9	2.6	8.7	4.7	4.6	91.4	0.11	21.8	8.0	2.3
25-024-SW3	6/23-24/93	Drumlummon - Silver Crk below tailings TP2, two miles below mills	Surface Water									0.12		3.6	74.4	2.6	8.7	5.9	7.3	262	0.11	41.3	8.0	6.8
SW-1	07/08/88	Goldsil Millsite - Silver Crk 3 mi. west of lower gate	Surface Water		8.3		150			11											0			
SW-2	07/08/88	Goldsil Millsite - Silver Crk 0.9 mi. west of lower gate	Surface Water		8.2		165			11											0			
SW-3	07/08/88	Goldsil Millsite - Silver Crk at upstream entrance to site	Surface Water		7.9		180			11		0	0	0	0	0		0	0	0	0	0	0	16.8
SW-4	07/08/88	Goldsil Millsite - Silver Crk N.E. corner of upper lagoon	Surface Water																		0			
SW-5	07/08/88	Goldsil Millsite - Silver Crk at downstream entrance to site	Surface Water		8.3		200			12		0	0	0	0	0	0	0	0	0	0	25	0	6.9
SW-6	07/08/88	Goldsil Millsite - Silver Crk just below lower lagoon	Surface Water		7.3		255			19											0			

Table 2-10. Summary of Silver Creek Drainage Surface Water Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Discharge (cfs)	Field pH (s.u.)	Lab pH (s.u.)	Field Specific Conductivity (umhos/cm)	Lab Specific Conductivity (umhos/cm)	Lab Turbidity (JTU)	Water Temp (C)	Oxidation Reduction Potential (mv)	Ag (ug/L) Total/Dissolved	Al (ug/L) Total/Dissolved	As (ug/L) Total/Dissolved	Ba (ug/L) Total/Dissolved	Cd (ug/L) Total/Dissolved	Co (ug/L)	Cr (ug/L) Total/Dissolved	Cu (ug/L) Total/Dissolved	Fe (ug/L) Total/Dissolved	Hg (ug/L) Total/Dissolved	Mn (ug/L) Total/Dissolved	Ni (ug/L) Total/Dissolved	Pb (ug/L) Total/Dissolved
		WQB-7-Human Health Standard	Surface Water									100		18	2000	5		100	1300	300	0.05	50	100	15
		WQB-7 Acute Aquatic Life Standard	Surface Water									13.4*	750	340		4.3*		NA**	26.9*		1.7		843.3*	197.3*
		WQB-7 Chronic Aquatic Life Standard	Surface Water										87	150		0.45*		NA**	16.9*	1000	0.91		93.8*	7.7*
SW-7	07/08/88	Goldsil Millsite - Silver Crk just below Buck Lake	Surface Water		7.3		200			16											0			
LL-1	07/08/88	Goldsil Millsite - spring below the lower lagoon	Surface Water		7.7		310			15		0	0	0		7	0	0	0	358	1.1	90	0	0
ML-1	07/08/88	Goldsil Millsite - lagoon just north of mill	Surface Water									0	0	74.5	0	0	0	19	35	294	9.8	19	0	17.3
UL-1	07/08/88	Goldsil Millsite - lagoon upstream from mill	Surface Water									269	3330	21.5	0	10	0	16	1160	6070	89	504	40	8.1
H7	12/07/81	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water	0.66		7.4		245	2.3			<5/<5	1700/<100	<5/<5	<100/<100	<1/<1		<20/<20	10/10	100/30	<1/<1	30/20		10/10
H7	06/10/82	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water	5.35															<10		<0.2			<10
H7	10/25/82	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water	0.88				250	1.3										<10/<10		<1/<1			10/10
H7	12/14/83	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water	0.52					2 (Est.)															
H9	10/21/81	Ottawa Gulch just above Obie Adit	Surface Water	0.65		7.8	235	230	3.7	1.2		<5/<5	100/<100	<5/<5	<100/<100	2/<1		<20/<20	10/<10	150/<30	0.2/0.2	<20/<20		<10/<10
H11	12/14/83	Jennies Fork; at county road bridge	Surface Water	0.048						2 (Est.)														
H12	12/14/83	Silver Creek; below Jennies Fork	Surface Water	0.65					2 (Est.)															
H13	12/14/83	Silver Creek above Sawmill Gulch	Surface Water	0.79					2 (Est.)															
H14	12/14/83	Sawmill Gulch above Silver Creek	Surface Water	0.5 (Est.)					2 (Est.)															
FG1/H15	10/21/76	Silver Creek; below China Gulch	Surface Water					348				10							<10		<0.2			<50
FG1/H15	11/15/74	Silver Creek; below China Gulch	Surface Water																					
FG1/H15	11/29/76	Silver Creek; below China Gulch	Surface Water																					
FG1/H16	10/21/76	Silver Creek; below China Gulch	Surface Water					414				10							<10		<0.2			<50
H17	11/23/74	Silver Creek above China Gulch	Surface Water				384			4.3														
H18	11/23/76	Silver Creek above China Gulch	Surface Water				357			3.6														
H19	11/23/76	Silver Creek above China Gulch	Surface Water				297			3.4														
H20	11/23/76	China Gulch above Silver Creek	Surface Water				371			3.0														
H21	11/23/76	Silver Creek; below China Gulch	Surface Water				321			3.3														
H22	11/23/76	Silver Creek above tailings	Surface Water				299			2.0														
H23	11/23/76	Silver Creek above tailings	Surface Water				333			3														
H24	11/23/76	Silver Creek at Mill	Surface Water				365			4.7														
H25	11/23/76	Silver Creek below Mill	Surface Water				365			4.5														
H26	11/23/76	Silver Creek near Clear Pond	Surface Water				373			3.9														
H27	11/23/76	Silver Creek above gravel road	Surface Water				383			3														
H28	11/23/76	Silver Creek above Sitzer	Surface Water				393			2.1														
WQ1/H6	09/17/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water		8.3	8.12		362				<10/<10		5/5		<5/<5			<10/<10	80/30	<.2/<.2			<50/<50
WQ1/H6	10/23/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water			8.43		372				<10							<10	30	<.2			
WQ1/H6	10/28/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water			8.48		345				<10							70	70	<.2			
WQ1/H6	10/29/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water	0.86				330				<1							30		<1			
WQ1/H6	10/30/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water																					
WQ1/H6	12/10/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water			7.75						<10							<10		<.2			
WQ1/H6	06/30/81	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water	6.34				340	2.0												<.2			
WQ2/H5	10/09/80	Silver Crk - at entrance to Goldsil mill	Surface Water			8.05		414				<10							<10		<.2			
WQ2/H5	10/15/80	Silver Crk - at entrance to Goldsil mill	Surface Water			8.08		385				<10							<10		<.2			
WQ2/H5	10/23/80	Silver Crk - at entrance to Goldsil mill	Surface Water			8.23		449				<10							<10	<0.13	<.2			
WQ2/H5	10/28/80	Silver Crk - at entrance to Goldsil mill	Surface Water			8.22		405				<10							<10	70	<.2			
WQ2/H5	10/29/80	Silver Crk - at entrance to Goldsil mill	Surface Water	2.12				400				<1							30		<1			
WQ2/H5	06/30/81	Silver Crk - at entrance to Goldsil mill	Surface Water	9.40				350	1.2												0.4			
WQ2/H5	06/10/82	Silver Crk - at entrance to Goldsil mill	Surface Water																		<.2			
WQ2/H5	10/25/82	Silver Crk - at entrance to Goldsil mill	Surface Water	2.19				393	1.4												<1/<1			
WQ2/H5	11/16/83	Silver Crk - at entrance to Goldsil mill	Surface Water																					
WQ12/H4	10/09/80	Silver Crk - above Upper Pond	Surface Water			7.93		414				<10							<10		<.2			
WQ12/H4	10/15/80	Silver Crk - above Upper Pond	Surface Water			8.20		393				<10							<10		<.2			
WQ12/H4	10/29/80	Silver Crk - above Upper Pond	Surface Water	2.32				400				<10							20		<1			
WQ12/H4	06/30/81	Silver Crk - above Upper Pond	Surface Water	8.05				350	1.4												0.3			
WQ10	10/28/80	Silver Crk - between Upper & Lower Ponds	Surface Water			8.32		441				<10							10	120	<.2			
WQ3/H3	10/09/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water			8.33		426				10							20		9			
WQ3/H3	10/15/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water			8.32		408				<10							<10		4			
WQ3/H3	10/23/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water			8.42		484				10							<10	130	0.8			
WQ3/H3	10/28/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water			8.33		431				<10							<10	0.11	<.2			
WQ3/H3	12/10/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water		7.10							<10							<10		<.2			
WQ5	10/09/80	Silver Crk - below seep	Surface Water			8.27		438				20							40		10			
WQ5	10/15/80	Silver Crk - below seep	Surface Water			8.30		395				10							20		12			
WQ5	10/23/80	Silver Crk - below seep	Surface Water			8.34		512				10							10	180	12			
WQ5	10/28/80	Silver Crk - below seep	Surface Water			8.40		447				<10							10	110	3			
WQ5	12/10/80	Silver Crk - below seep	Surface Water			8.16						<10							10		0.2			

Table 2-10. Summary of Silver Creek Drainage Surface Water Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Discharge (cfs)	Field pH (s.u.)	Lab pH (s.u.)	Field Specific Conductivity (umhos/cm)	Lab Specific Conductivity (umhos/cm)	Lab Turbidity (JTU)	Water Temp (C)	Oxidation Reduction Potential (mv)	Ag (ug/L) Total/Dissolved	Al (ug/L) Total/Dissolved	As (ug/L) Total/Dissolved	Ba (ug/L) Total/Dissolved	Cd (ug/L) Total/Dissolved	Co (ug/L)	Cr (ug/L) Total/Dissolved	Cu (ug/L) Total/Dissolved	Fe (ug/L) Total/Dissolved	Hg (ug/L) Total/Dissolved	Mn (ug/L) Total/Dissolved	Ni (ug/L) Total/Dissolved	Pb (ug/L) Total/Dissolved
		WQB-7-Human Health Standard	Surface Water									100		18	2000	5		100	1300	300	0.05	50	100	15
		WQB-7 Acute Aquatic Life Standard	Surface Water									13.4*	750	340		4.3*		NA**	26.9*		1.7		843.3*	197.3*
		WQB-7 Chronic Aquatic Life Standard	Surface Water										87	150		0.45*		NA**	16.9*	1000	0.91		93.8*	7.7*
WQ6/H2	11/15/76	Silver Crk - below seep	Surface Water																					
WQ6/H2	11/29/76	Silver Crk - below seep	Surface Water																					
WQ6/H2	09/17/80	Silver Crk - above Buck Lake	Surface Water		8.4	8.34		420				<20/<10		6/6		<5/<5			60/70	90/50	7/7			<50/<50
WQ6/H2	10/09/80	Silver Crk - above Buck Lake	Surface Water			8.34		429				10							30		9			
WQ6/H2	10/15/80	Silver Crk - above Buck Lake	Surface Water			8.29		423				<10							20		8			
WQ6/H2	10/23/80	Silver Crk - above Buck Lake	Surface Water			8.33		516				10							10	180	6			
WQ6/H2	10/28/80	Silver Crk - above Buck Lake	Surface Water			8.29		448				<10							10	110	2			
WQ6/H2	10/29/80	Silver Crk - above Buck Lake	Surface Water	2.78				410				2							30		9.1			
WQ6/H2	06/30/81	Silver Crk - above Buck Lake	Surface Water	8.14				355	2.4												0.3			
WQ6/H2	06/21/82	Silver Crk - above Buck Lake	Surface Water																					
WQ6/H2	10/25/82	Silver Crk - above Buck Lake	Surface Water	2.14				396	4.8												<1/<1			
WQ4/H1	09/17/80	Silver Crk - seep	Surface Water		7.9	7.76		762				120/420		2/2		5/5			5500/5500	130/100	850/840			50/50
WQ4/H1	10/23/80	Silver Crk - seep	Surface Water			7.56		791				800							1000	40	800			
WQ4/H1	10/28/80	Silver Crk - seep	Surface Water			7.56		759				90							710	110	800			
WQ4/H1	10/29/80	Silver Crk - seep	Surface Water	0.009				690				32							500		1030			
WQ4/H1	10/29/80	Silver Crk - seep	Surface Water	0.009																				
WQ4/H1	12/10/80	Silver Crk - seep	Surface Water			7.64						20							30		200			
WQ4/H1	06/30/81	Silver Crk - seep	Surface Water	0.003				640	0.55												38			
WQ4/H1	06/30/81	Silver Crk - seep	Surface Water	0.003				640	0.62												42			
WQ4/H1	06/21/82	Silver Crk - seep	Surface Water																					
WQ4/H1	10/25/82	Silver Crk - seep	Surface Water					605	1.3												8/8			
WQ4/H1	10/25/82	Silver Crk - seep	Surface Water	2.14				396	4.8												1/1			
WQ7	10/09/80	Silver Crk - below Buck Lake	Surface Water			8.05		400				10							30		1.6			
WQ7	10/23/80	Silver Crk - below Buck Lake	Surface Water			8.14		486				10							10	80	4			
WQ7	10/28/80	Silver Crk - below Buck Lake	Surface Water			8.18		457				<10							10	80	2			
WQ7	12/10/80	Silver Crk - below Buck Lake	Surface Water			7.94						<10							10		<.2			
WQ8	10/23/80	Goldsil - Upper Holding Pond (clear water)	Surface Water			8.45		438				<10							<10	210	<.2			
WQ8	10/28/80	Goldsil - Upper Holding Pond (clear water)	Surface Water			8.33		414				<10							10	190	<.2			
WQ9	10/23/80	Goldsil - Lower Tailings Pond	Surface Water			8.66		415				20							240	340	80			
WQ9	10/28/80	Goldsil - Lower Tailings Pond	Surface Water			8.50		398				40							270	240	120			
WQ10	10/28/80	Silver Crk - below Clear Pond	Surface Water			8.32		441				<10							10	120	<.2			
WQ11	12/10/80	Silver Crk - Birdseye Road	Surface Water			7.90						<10							<10		<.2			
Sawmill C	11/20/80	Sawmill Crk	Surface Water	2.0	6.3	8.43	340	415		1										60		10		
Sawmill C	09/19/81	Sawmill Crk	Surface Water	1.0	6.2	7.00	340	390.6		3									9			8		
Ottawa C	12/78	Ottawa Crk	Surface Water																	<10		<10		
Ottawa C	01/30/79	Ottawa Crk	Surface Water																	<10		<10		
Station #1	10/21/76	Silver Creek below China Gulch	Surface Water					348				10							<10		<.2			<50
Station #1	11/15/76	Silver Creek below China Gulch	Surface Water																					
Station #1	11/29/76	Silver Creek below China Gulch	Surface Water																					
Station #1	01/12/77	Silver Creek below China Gulch	Surface Water													<1			<10	90			<50	
Station #1	01/31/77	Silver Creek below China Gulch	Surface Water																					
Station #1A	01/31/77	Silver Creek near Goldsil tailings pile	Surface Water																					
Station #2A	01/12/77	Pond between mill and no trespassing access road east of mill	Surface Water													<1			<10	320			<50	
Station #2B	01/12/77	Silver Creek between mill and upper tailings pond at headgate	Surface Water													<1			<10	250			<50	
Station #3	10/21/76	Upper tailings pond	Surface Water					1191				410							8000		140			<50
Station #3	11/15/76	Upper tailings pond	Surface Water																					
Station #3	01/12/77	Upper tailings pond	Surface Water													<1			28000	20			90	
Station #6	11/15/76	Silver Creek below lower tailings pond	Surface Water																					
Station #6	11/29/76	Silver Creek below lower tailings pond	Surface Water																					
Station #6	01/12/77	Silver Creek below lower tailings pond	Surface Water													<1			10	100			<50	
Station #6	01/31/77	Silver Creek below lower tailings pond	Surface Water																					
Station #7	10/21/76	Silver Creek at gravel road 0.9 mile from Lincoln highway	Surface Water					414				10							<10		<.2			<50

Note: WQB-7 standards for metals (except aluminum) in surface water are based upon the analysis of total recoverable metals.
Aluminum is based on dissolved metals.

*Based on a hardness of 200 mg/l as $CaCO_3$ (note that average hardness for previous data is 190 mg/l $CaCO_3$)

**Aquatic life standards are based on specization of Cr(III) and Cr(VI). The analyses performed were total Cr.

Table 2-10. Summary of Silver Creek Drainage Surface Water Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Sb (ug/L) Total/Dissolved	Se (ug/L) Total/Dissolved	Zn (ug/L) Total/Dissolved	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Hardness (mg $CaCO_3$/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Carbonate as CO_3 (mg/L)	Bicarbonate as HCO_3 (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	NO_3/NO_2-N (mg/L)	Total Cyanide (mg/L)	Source/Date
		WQB-7-Human Health Standard	Surface Water	6	50	2000													10000	200	
		WQB-7 Acute Aquatic Life Standard	Surface Water		20	215.6*														22	
		WQB-7 Chronic Aquatic Life Standard	Surface Water		5	215.6*														5.2	
Culvert Intake	03/27/02	Silver Crk Ranchette Rd.	Surface Water	ND		20															DEQ/MWCB, 2002
Transfer Station Rd	03/27/02	Silver Crk - at Transfer Station Rd.	Surface Water	ND		ND															DEQ/MWCB, 2002
25-200-SW-01	10/11/95	Rawhide Gulch at Ski road	Surface Water		5/5	20/20	29.0	3.0	1.0	1.0	85		111	0	98	80	2	10	0.08	0.005	Maxim, 1996
25-200-SW-01	02/08/96	Rawhide Gulch at Ski road	Surface Water		5/5	40/30	28.0	4.0	1.0	1.0	86		118	0	104	85	2	10	0.13		Maxim, 1996
25-200-SW-01	05/01/96	Rawhide Gulch at Ski road	Surface Water		5/5	20/20	26.0	3.0	1.0	1.0	77		115	0	95	78	1	9	0.16	0.005	Maxim, 1996
25-200-SW-01	08/28/96	Rawhide Gulch at Ski road	Surface Water		5/5	30/30	27.0	4.0	1.0	1.0	84		126	0	92	75	1	10	0.05	0.005	Maxim, 1996
25-200-SW-02	10/11/95	Silver Creek at Marysville	Surface Water		5/5	20/30	38.0	4.0	1.0	1.0	111		195	0	135	111	1	10	0.20	0.005	Maxim, 1996
25-200-SW-02	02/08/96	Silver Creek at Marysville	Surface Water		5/5	20/20	40.0	4.0	1.0	2.0	116		136	0	121	99	3	13	0.33	0.005	Maxim, 1996
25-200-SW-02	05/01/96	Silver Creek at Marysville	Surface Water		5/5	20/20	42.0	3.0	1.0	2.0	117		139	0	135	111	2	11	0.26	0.005	Maxim, 1996
25-200-SW-02	08/28/96	Silver Creek at Marysville	Surface Water		5/5	30/20	44.0	5.0	1.0	2.0	130		163	0	149	122	1	10	0.27	0.005	Maxim, 1996
25-200-SW-02A	08/28/96	Silver Creek immediately below Drumlummon waste rock pile	Surface Water		5/5	100/30	44.0	6.0	1.0	2.0	135		159	0	149	122	1	10	0.29	0.005	Maxim, 1996
25-200-SW-03	10/11/95	Jennies Fork; at County Road	Surface Water		5/5	30/20	48.0	6.0	10.0	1.0	145		186	0	159	130	2	21	0.88	0.005	Maxim, 1996
25-200-SW-03	02/08/96	Jennies Fork; at County Road	Surface Water		5/5	20/20	46.0	8.0	3.0	2.0	148		171	0	144	118	3	22	0.70	0.005	Maxim, 1996
25-200-SW-03	05/01/96	Jennies Fork; at County Road	Surface Water		5/5	20/20	41.0	7.0	1.0	2.0	131		182	0	144	118	3	20	0.72	0.005	Maxim, 1996
25-200-SW-04	10/11/95	Silver Creek at Skid Road (continuous recorder station)	Surface Water		5/5	30/20	52.0	5.0	1.0	1.0	150		193	0	153	125	3	18	0.43	0.005	Maxim, 1996
25-200-SW-04	02/08/96	Silver Creek at Skid Road (continuous recorder station)	Surface Water		5/5	70/20	35.0	6.0	1.0	2.0	112		88	0	110	90	5	17	0.33		Maxim, 1996
25-200-SW-04	05/01/96	Silver Creek at Skid Road (continuous recorder station)	Surface Water		5/5	20/20	45.0	4.0	1.0	2.0	129		161	0	144	118	1	17	0.5	0.005	Maxim, 1996
25-200-SW-04	08/28/96	Silver Creek at Skid Road (continuous recorder station)	Surface Water		5/5	90/40	48.0	6.0	1.0	2.0	145		179	0	154	126	1	15	0.49	0.005	Maxim, 1996
25-200-SW-05	10/11/95	Sawmill Gulch	Surface Water		5/5	30/90	53.0	13.0	1.0	1.0	186		228	0	225	184	1	18	0.05	0.005	Maxim, 1996
25-200-SW-05	02/08/96	Sawmill Gulch	Surface Water		5/5	20/20	44.0	13.0	1.0	2.0	163		145	0	167	137	1	16	0.19		Maxim, 1996
25-200-SW-05	05/01/96	Sawmill Gulch	Surface Water		5/5	20/20	55.0	14.0	1.0	2.0	195		225	6	213	184	1	17	0.18	0.005	Maxim, 1996
25-200-SW-06	10/11/95	Silver Creek immediately above reclaimed tailings channel	Surface Water		5/5	20/20	50.0	8.0	9.0	2.0	158		192	0	187	153	2	16	0.20	0.005	Maxim, 1996
25-200-SW-06	02/08/96	Silver Creek immediately above reclaimed tailings channel	Surface Water		5/5	130/20	45.0	8.0	1.0	2.0	145		108	0	161	132	1	16	0.47		Maxim, 1996
25-200-SW-06	05/01/96	Silver Creek immediately above reclaimed tailings channel	Surface Water		5/5	20/20	52.0	9.0	1.0	2.0	167		207	0	184	151	2	18	0.29	0.005	Maxim, 1996
25-200-SW-06	08/28/96	Silver Creek immediately above reclaimed tailings channel	Surface Water		5/5	20/20	53.0	9.0	1.0	2.0	169		199	0	188	154	1	16	0.26	0.005	Maxim, 1996
25-200-SW-07	10/11/95	Silver Creek at Goldsil, second culvert	Surface Water		5/5	80/20	64.0	13.0	1.0	2.0	213		250	0	250	205	3	15	0.01	0.005	Maxim, 1996
25-200-SW-07	10/11/95	Duplicate 25-200-SW-07 (10/11/95)	Surface Water		5/5	20/30	64.0	14.0	1.0	2.0	217		262	0	254	208	3	15	0.01	0.005	Maxim, 1996
25-200-SW-07	02/08/96	Silver Creek at Goldsil, second culvert	Surface Water		5/5	70/20	44.0	9.0	1.0	3.0	147		161	0	161	132	3	14	0.15	0.005	Maxim, 1996
25-200-SW-07	05/01/96	Silver Creek at Goldsil, second culvert	Surface Water		5/5	20/20	49.0	12.0	1.0	2.0	172		216	6	190	165	1	18	0.10	0.005	Maxim, 1996
25-200-SW-07	05/01/96	Duplicate 25-200-SW-07 (05/01/96)	Surface Water		5/5	20/20	54.0	11.0	1.0	2.0	180		209	6	201	165	2	18	0.11	0.005	Maxim, 1996
25-200-SW-07	08/28/96	Silver Creek at Goldsil, second culvert	Surface Water		5/5	40/40	59.0	13.0	1.0	2.0	201		230	0	234	192	1	14	0.06	0.005	Maxim, 1996
25-200-SW-08	10/11/95	Sitzer Gulch at Birdseye Road	Surface Water		5/5	20/20	90.0	40.0	30.0	3.0	389		552	0	345	283	9	142	0.01	0.007	Maxim, 1996
25-200-SW-08	02/08/96	Sitzer Gulch at Birdseye Road	Surface Water		5/5	80/20	20.0	8.0	1.0	8.0	83		67	0	81	66	2	33	0.16	0.005	Maxim, 1996
25-200-SW-08	05/01/96	Sitzer Gulch at Birdseye Road	Surface Water		5/5	20/20	75.0	36.0	16.0	4.0	336		462	0	305	250	9	128	0.06	0.005	Maxim, 1996
25-200-SW-09	10/11/95	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water		5/5	110/20	64.0	18.0	4.0	2.0	234		279	0	259	212	3	31	0.01	0.005	Maxim, 1996
25-200-SW-09	02/08/96	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water		5/5	60/20	21.0	8.0	1.0	6.0	85		102	0	81	66	3	24	0.09		Maxim, 1996
25-200-SW-09	05/01/96	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water		5/5	20/20	51.0	18.0	1.0	3.0	201		244	6	213	184	2	27	0.03	0.005	Maxim, 1996
25-200-SW-09	08/28/96	Silver Creek at railroad trestle below Sitzer (continous recorder sta.)	Surface Water		5/5	60/30	56.0	17.0	1.0	2.0	210		251	0	245	201	3	10	0.05	0.009	Maxim, 1996
25-200-SW-10	10/11/95	Threemile Creek	Surface Water		5/5	20/40	43.0	24.0	12.0	1.0	206		228	0	245	201	2	16	0.01	0.005	Maxim, 1996
25-200-SW-10	02/08/96	Threemile Creek	Surface Water		5/5	60/20	12.0	4.0	1.0	3.0	46		38	0	57	47	2	8	0.21	0.005	Maxim, 1996
25-200-SW-10	05/01/96	Threemile Creek	Surface Water		5/5	20/20	40.0	25.0	4.0	2.0	203		224	0	225	184	2	17	0.04	0.005	Maxim, 1996
25-200-SW-11	10/11/95	Silver Creek at Silver Creek Estates Road	Surface Water		5/5	20/20	98.0	35.0	29.0	4.0	389		555	0	366	300	10	132	0.05	0.005	Maxim, 1996
25-200-SW-11	02/08/96	Silver Creek at Silver Creek Estates Road	Surface Water		5/5	60/20	19.0	6.0	2.0	8.0	72		123	0	74	61	2	21	0.20		Maxim, 1996
25-200-SW-11	02/08/96	Duplicate 25-200-SW-11 (02/08/96)	Surface Water		5/5	50/20	18.0	6.0	2.0	6.0	70		142	0	74	61	4	21	0.14	0.005	Maxim, 1996
25-200-SW-11	05/01/96	Silver Creek at Silver Creek Estates Road	Surface Water		5/5	20/20	71.0	30.0	8.0	4.0	301		377	6	265	227	5	85	0.03	0.005	Maxim, 1996
25-200-SW-11	08/28/96	Silver Creek at Silver Creek Estates Road	Surface Water		5/5	60/50	112.0	48.0	22.0	5.0	477		646	0	411	337	9	169	0.05	0.009	Maxim, 1996
25-200-SW-11	08/28/96	Duplicate 25-200-SW-11 (08/28/96)	Surface Water		5/5	60/30	109.0	47.0	21.0	5.0	466		656	0	417	342	9	170	0.05	0.005	Maxim, 1996
25-365-SW-1	09/02/93	Goldsil Millsite - at toe of berm w/flow gate in Silver Crk	Surface Water	31.7		8.71					212		213				<5	19	<0.05	<0.005	MDSL/AMRB, 1993a
25-365-SW-2	09/02/93	Goldsil Millsite - Silver Crk at culvert (downgradient) at rd.	Surface Water	31.7		12.3					195		212				<5	18	0.06	<0.005	MDSL/AMRB, 1993a
25-365-SW-3	09/02/93	Goldsil Millsite - Silver Crk upgradient (200') from Argo mill bldg.	Surface Water	31.7		12.4					181		189				<5	18	0.09	<0.005	MDSL/AMRB, 1993a
25-365-SW-5	09/02/93	Goldsil Millsite - pregnant pond below mill	Surface Water																	<0.005	MDSL/AMRB, 1993a
25-024-AD1	6/23-24/93	Drumlummon - Adit discharge on WR4	Surface Water	29.4		6.07					319		309				<5	24	<0.05		MDSL/AMRB, 1993b
25-024-SW1	6/23-24/93	Drumlummon - Ottawa Gulch (Silver Crk) upstream of mines and mills	Surface Water	29.4		6.67					144		137				<5	8.0	0.15		MDSL/AMRB, 1993b
25-024-SW2	6/23-24/93	Drumlummon - Silver Crk below mines, mills and TP1	Surface Water	29.4		4.5					139		148				<5	12	0.16		MDSL/AMRB, 1994
25-024-SW3	6/23-24/93	Drumlummon - Silver Crk below tailings TP2, two miles below mills	Surface Water	29.4		13.7					188		177.00				<5	18	0.14		MDSL/AMRB, 1994
SW-1	07/08/88	Goldsil Millsite - Silver Crk 3 mi. west of lower gate	Surface Water																	0	MDHES, 1988
SW-2	07/08/88	Goldsil Millsite - Silver Crk 0.9 mi. west of lower gate	Surface Water																	0	MDHES, 1988
SW-3	07/08/88	Goldsil Millsite - Silver Crk at upstream entrance to site	Surface Water	0	0	0	53.2	8.35	0	0										0	MDHES, 1988
SW-4	07/08/88	Goldsil Millsite - Silver Crk N.E. corner of upper lagoon	Surface Water																	0	MDHES, 1988
SW-5	07/08/88	Goldsil Millsite - Silver Crk at downstream entrance to site	Surface Water	0	0	0	58.0	12.3	0	0										0.005	MDHES, 1988
SW-6	07/08/88	Goldsil Millsite - Silver Crk just below lower lagoon	Surface Water																	0	MDHES, 1988

Table 2-10. Summary of Silver Creek Drainage Surface Water Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Sb (ug/L) Total/Dissolved	Se (ug/L) Total/Dissolved	Zn (ug/L) Total/Dissolved	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Hardness (mg $CaCO_3$/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Carbonate as CO_3 (mg/L)	Bicarbonate as HCO_3 (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	NO_3/NO_2-N (mg/L)	Total Cyanide (mg/L)	Source/Date
		WQB-7-Human Health Standard	Surface Water	6	50	2000													10000	200	
		WQB-7 Acute Aquatic Life Standard	Surface Water		20	215.6*														22	
		WQB-7 Chronic Aquatic Life Standard	Surface Water		5	215.6*														5.2	
SW-7	07/08/88	Goldsil Millsite - Silver Crk just below Buck Lake	Surface Water																	0	MDHES, 1988
LL-1	07/08/88	Goldsil Millsite - spring below the lower lagoon	Surface Water	0	0	0	69.4	22.9	8.21	0										1.690	MDHES, 1988
ML-1	07/08/88	Goldsil Millsite - lagoon just north of mill	Surface Water	0	0	38	15.2	5.0	0	0										0	MDHES, 1988
UL-1	07/08/88	Goldsil Millsite - lagoon upstream from mill	Surface Water	276	12.5	2040	17.2	5.11	154	16.8										0.325	MDHES, 1988
H7	12/07/81	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water		<5/<5	<10/<10	39	5	4	2	117	10	133.00	0	131.00	108.00	17	1			Goldsil Mining and Milling, Inc., 1984
H7	06/10/82	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water			<10														0.408	Hydrometrics, 1983
H7	10/25/82	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water			<10/<10															Hydrometrics, 1983
H7	12/14/83	Silver Crk - above Maskelyne Tunnel; above mine office entrance road	Surface Water																		Hydrometrics, 1983
H9	10/21/81	Ottawa Gulch just above Obie Adit	Surface Water		<5/<5	10/10	47	5	1	2	134	<1	143	0	147	120	13	2			Goldsil Mining and Milling, Inc., 1984
H11	12/14/83	Jennies Fork; at county road bridge	Surface Water																		Hydrometrics, 1983
H12	12/14/83	Silver Creek; below Jennies Fork	Surface Water																		Hydrometrics, 1983
H13	12/14/83	Silver Creek above Sawmill Gulch	Surface Water																		Hydrometrics, 1983
H14	12/14/83	Sawmill Gulch above Silver Creek	Surface Water																		Hydrometrics, 1983
FG1/H15	10/21/76	Silver Creek; below China Gulch	Surface Water			<10	55	9.9	4.0	1.8						171	0.21	12		<20	Goldsil Mining and Milling, Inc., 1984
FG1/H15	11/15/74	Silver Creek; below China Gulch	Surface Water																	<2	Goldsil Mining and Milling, Inc., 1984
FG1/H15	11/29/76	Silver Creek; below China Gulch	Surface Water																	<1	Goldsil Mining and Milling, Inc., 1984
FG1/H16	10/21/76	Silver Creek; below China Gulch	Surface Water			<10	56	17	5.5	2.0						201	3.3	13			Goldsil Mining and Milling, Inc., 1984
H17	11/23/74	Silver Creek above China Gulch	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H18	11/23/76	Silver Creek above China Gulch	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H19	11/23/76	Silver Creek above China Gulch	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H20	11/23/76	China Gulch above Silver Creek	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H21	11/23/76	Silver Creek; below China Gulch	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H22	11/23/76	Silver Creek above tailings	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H23	11/23/76	Silver Creek above tailings	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H24	11/23/76	Silver Creek at Mill	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H25	11/23/76	Silver Creek below Mill	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H26	11/23/76	Silver Creek near Clear Pond	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H27	11/23/76	Silver Creek above gravel road	Surface Water																		Goldsil Mining and Milling, Inc., 1984
H28	11/23/76	Silver Creek above Sitzer	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ1/H6	09/17/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water			<5/6	54.6	10.1			178			0.0	173.2	142	1.2	17.1			Goldsil Mining and Milling, Inc., 1984
WQ1/H6	10/23/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water				51.4	10.0			170			0.0	186.7	153	1.4			0.009	Goldsil Mining and Milling, Inc., 1984
WQ1/H6	10/28/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water				59.9	9.1			187			0.0	187.9	154	1.4			<0.005	Goldsil Mining and Milling, Inc., 1984
WQ1/H6	10/29/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water						4											<0.005	Goldsil Mining and Milling, Inc., 1984
WQ1/H6	10/30/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water																	<0.005	Goldsil Mining and Milling, Inc., 1984
WQ1/H6	12/10/80	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water																	<0.001	Goldsil Mining and Milling, Inc., 1984
WQ1/H6	06/30/81	Silver Crk - above Goldsil; at culvert at mill office entrance road	Surface Water						5											<0.005	Goldsil Mining and Milling, Inc., 1984
WQ2/H5	10/09/80	Silver Crk - at entrance to Goldsil mill	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ2/H5	10/15/80	Silver Crk - at entrance to Goldsil mill	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ2/H5	10/23/80	Silver Crk - at entrance to Goldsil mill	Surface Water				59.1	15.4			211			0.0	226.9	186	1.7			0.010	Goldsil Mining and Milling, Inc., 1984
WQ2/H5	10/28/80	Silver Crk - at entrance to Goldsil mill	Surface Water				64.8	13.6			218			0.0	219.6	180				<0.005	Goldsil Mining and Milling, Inc., 1984
WQ2/H5	10/29/80	Silver Crk - at entrance to Goldsil mill	Surface Water						5											0.019	Goldsil Mining and Milling, Inc., 1984
WQ2/H5	06/30/81	Silver Crk - at entrance to Goldsil mill	Surface Water						5											<0.005	Goldsil Mining and Milling, Inc., 1984
WQ2/H5	06/10/82	Silver Crk - at entrance to Goldsil mill	Surface Water																	0.011	Hydrometrics, 1983
WQ2/H5	10/25/82	Silver Crk - at entrance to Goldsil mill	Surface Water																	<0.005	Hydrometrics, 1983
WQ2/H5	11/16/83	Silver Crk - at entrance to Goldsil mill	Surface Water																	<0.005	Hydrometrics, 1983
WQ12/H4	10/09/80	Silver Crk - above Upper Pond	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ12/H4	10/15/80	Silver Crk - above Upper Pond	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ12/H4	10/29/80	Silver Crk - above Upper Pond	Surface Water						5											<0.005	Goldsil Mining and Milling, Inc., 1984
WQ12/H4	06/30/81	Silver Crk - above Upper Pond	Surface Water						5											<0.005	Goldsil Mining and Milling, Inc., 1984
WQ10	10/28/80	Silver Crk - between Upper & Lower Ponds	Surface Water				63.5	15.9			224			0.0	229.4	188	1.9			<0.005	Goldsil Mining and Milling, Inc., 1984
WQ3/H3	10/09/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ3/H3	10/15/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ3/H3	10/23/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water				60.9	14.5			212			0.0	245.2	201	3.2			0.15	Goldsil Mining and Milling, Inc., 1984
WQ3/H3	10/28/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water				66.8	16.8			236			0.0	234.2	192	2.3			0.028	Goldsil Mining and Milling, Inc., 1984
WQ3/H3	12/10/80	Silver Crk - above seep; opposite White's tailings pond	Surface Water																	0.021	Goldsil Mining and Milling, Inc., 1984
WQ5	10/09/80	Silver Crk - below seep	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ5	10/15/80	Silver Crk - below seep	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ5	10/23/80	Silver Crk - below seep	Surface Water				65.1	26.7			272			0.0	246.4	202	4.5			0.10	Goldsil Mining and Milling, Inc., 1984
WQ5	10/28/80	Silver Crk - below seep	Surface Water				65.4	16.8			232			0.0	233.0	191	2.8			0.051	Goldsil Mining and Milling, Inc., 1984
WQ5	12/10/80	Silver Crk - below seep	Surface Water																	0.029	Goldsil Mining and Milling, Inc., 1984

Table 2-10. Summary of Silver Creek Drainage Surface Water Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Sb (ug/L) Total/Dissolved	Se (ug/L) Total/Dissolved	Zn (ug/L) Total/Dissolved	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Hardness (mg $CaCO_3$/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Carbonate as CO_3 (mg/L)	Bicarbonate as HCO_3 (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	NO_3/NO_2-N (mg/L)	Total Cyanide (mg/L)	Source/Date
		WQB-7-Human Health Standard	Surface Water	6	50	2000													10000	200	
		WQB-7 Acute Aquatic Life Standard	Surface Water		20	215.6*														22	
		WQB-7 Chronic Aquatic Life Standard	Surface Water		5	215.6*														5.2	
WQ6/H2	11/15/76	Silver Crk - below seep	Surface Water																	0.010	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	11/29/76	Silver Crk - below seep	Surface Water																	0.008	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	09/17/80	Silver Crk - above Buck Lake	Surface Water			<5/20	55.9	15.3			202			0.0	224.5	184	2.8	21.4		0.117	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	10/09/80	Silver Crk - above Buck Lake	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ6/H2	10/15/80	Silver Crk - above Buck Lake	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ6/H2	10/23/80	Silver Crk - above Buck Lake	Surface Water				63.3	18.2			233			0.0	245.2	201	4.4			0.10	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	10/28/80	Silver Crk - above Buck Lake	Surface Water				65.6	15.4			227			0.0	233.0	191	2.9			0.041	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	10/29/80	Silver Crk - above Buck Lake	Surface Water						9											0.062	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	06/30/81	Silver Crk - above Buck Lake	Surface Water						6											<0.005	Goldsil Mining and Milling, Inc., 1984
WQ6/H2	06/21/82	Silver Crk - above Buck Lake	Surface Water																	0.011	Hydrometrics, 1983
WQ6/H2	10/25/82	Silver Crk - above Buck Lake	Surface Water																	0.009	Hydrometrics, 1983
WQ4/H1	09/17/80	Silver Crk - seep	Surface Water			10/10	61.5	19.7			235			0.0	251.3	206	70.3	106.0		8.6	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	10/23/80	Silver Crk - seep	Surface Water				62.1	20.0			237			0.0	263.0	232	44.4			2.0	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	10/28/80	Silver Crk - seep	Surface Water				67.2	18.2			243			0.0	273.3	224	40.4			1.31	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	10/29/80	Silver Crk - seep	Surface Water						65											0.98	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	10/29/80	Silver Crk - seep	Surface Water																	0.86	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	12/10/80	Silver Crk - seep	Surface Water																	0.462	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	06/30/81	Silver Crk - seep	Surface Water						33											0.15	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	06/30/81	Silver Crk - seep	Surface Water						34											0.17	Goldsil Mining and Milling, Inc., 1984
WQ4/H1	06/21/82	Silver Crk - seep	Surface Water																	0.408	Hydrometrics, 1983
WQ4/H1	10/25/82	Silver Crk - seep	Surface Water																	0.354	Hydrometrics, 1983
WQ4/H1	10/25/82	Silver Crk - seep	Surface Water																	0.009	Hydrometrics, 1983
WQ7	10/09/80	Silver Crk - below Buck Lake	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ7	10/23/80	Silver Crk - below Buck Lake	Surface Water				62.3	18.6			232			0.0	236.7	194	4.3			0.020	Goldsil Mining and Milling, Inc., 1984
WQ7	10/28/80	Silver Crk - below Buck Lake	Surface Water				65.3	17.7			236			0.0	230.6	189	3.3			0.075	Goldsil Mining and Milling, Inc., 1984
WQ7	12/10/80	Silver Crk - below Buck Lake	Surface Water																		Goldsil Mining and Milling, Inc., 1984
WQ8	10/23/80	Goldsil - Upper Holding Pond (clear water)	Surface Water				59.0	15.3			210			0.0	229.4	188	1.8			0.7	Goldsil Mining and Milling, Inc., 1984
WQ8	10/28/80	Goldsil - Upper Holding Pond (clear water)	Surface Water				67.5	14.1			227			0.0	220.8	181	1.9			<0.005	Goldsil Mining and Milling, Inc., 1984
WQ9	10/23/80	Goldsil - Lower Tailings Pond	Surface Water				57.1	14.5			202			0.0	194.0	139	3.3			0.29	Goldsil Mining and Milling, Inc., 1984
WQ9	10/28/80	Goldsil - Lower Tailings Pond	Surface Water				47.3	13.6			174			0.0	187.9	154	4.1			0.328	Goldsil Mining and Milling, Inc., 1984
WQ10	10/28/80	Silver Crk - below Clear Pond	Surface Water				63.5	15.9			224			0.0	229.4	188	1.9			<0.005	Goldsil Mining and Milling, Inc., 1984
WQ11	12/10/80	Silver Crk - Birdseye Road	Surface Water																		Goldsil Mining and Milling, Inc., 1984
Sawmill C	11/20/80	Sawmill Crk	Surface Water				61.8	14.8	1.9	2.6	215.23	5.39	231.4	1.7	235	195.58	1.5	21.2	0.07		Goldsil Mining and Milling, Inc., 1984
Sawmill C	09/19/81	Sawmill Crk	Surface Water				56.4	14.4	2.0	2.5	200.10	29.5	219.05	0	225	184.54	1.0	22.2	0.084		Goldsil Mining and Milling, Inc., 1984
Ottawa C	12/78	Ottawa Crk	Surface Water				45.9	4.3	2.2	2.1				0	149.0		0.65	14.2	0.418		Goldsil Mining and Milling, Inc., 1984
Ottawa C	01/30/79	Ottawa Crk	Surface Water				46.8	4.4	2.3	2.2				0	146		8	16.2	0.474		Goldsil Mining and Milling, Inc., 1984
Station #1	10/21/76	Silver Creek below China Gulch	Surface Water			<10	55	9.9	4.0	1.8						171	0.21	12		<0.02	MT Dept. of Fish and Game, 1977
Station #1	11/15/76	Silver Creek below China Gulch	Surface Water																	<0.002	MT Dept. of Fish and Game, 1977
Station #1	11/29/76	Silver Creek below China Gulch	Surface Water																	0.001	MT Dept. of Fish and Game, 1977
Station #1	01/12/77	Silver Creek below China Gulch	Surface Water			<10														<0.001	MT Dept. of Fish and Game, 1977
Station #1	01/31/77	Silver Creek below China Gulch	Surface Water																	0.002	MT Dept. of Fish and Game, 1977
Station #1A	01/31/77	Silver Creek near Goldsil tailings pile	Surface Water																	<0.001	MT Dept. of Fish and Game, 1977
Station #2A	01/12/77	Pond between mill and no trespassing access road east of mill	Surface Water			<10														0.008	MT Dept. of Fish and Game, 1977
Station #2B	01/12/77	Silver Creek between mill and upper tailings pond at headgate	Surface Water			<10														<0.001	MT Dept. of Fish and Game, 1977
Station #3	10/21/76	Upper tailings pond	Surface Water			680	89	51	93	39						237	148	230		6.5	MT Dept. of Fish and Game, 1977
Station #3	11/15/76	Upper tailings pond	Surface Water																	6.95	MT Dept. of Fish and Game, 1977
Station #3	01/12/77	Upper tailings pond	Surface Water			6500														22.0	MT Dept. of Fish and Game, 1977
Station #6	11/15/76	Silver Creek below lower tailings pond	Surface Water																	0.010	MT Dept. of Fish and Game, 1977
Station #6	11/29/76	Silver Creek below lower tailings pond	Surface Water																	0.008	MT Dept. of Fish and Game, 1977
Station #6	01/12/77	Silver Creek below lower tailings pond	Surface Water			<10															MT Dept. of Fish and Game, 1977
Station #6	01/31/77	Silver Creek below lower tailings pond	Surface Water																	0.008	MT Dept. of Fish and Game, 1977
Station #7	10/21/76	Silver Creek at gravel road 0.9 mile from Lincoln highway	Surface Water			<10	56	17	5.5	2.0						201	3.3	13		<0.02	MT Dept. of Fish and Game, 1977

Note: WQB-7 standards for metals (except aluminum) in surface water are based upon the analysis of total recoverable metals.
Aluminum is based on dissolved metals.

*Based on a hardness of 200 mg/l as $CaCO_3$ (note that average hardness for previous data is 190 mg/l $CaCO_3$)

**Aquatic life standards are based on specization of Cr(III) and Cr(VI). The analyses performed were total Cr.

Table 2-11. Summary of Previous Silver Creek Drainage Groundwater and Adit Discharge Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Well Depth (ft.)	Aquifer	Discharge (cfs)	Field pH (s.u.)	Lab pH (s.u.)	Field Specific Conductivity (umhos/cm)	Lab Specific Conductivity (umhos/cm)	Lab Turbidity (JTU)	Water Temp (C)	Oxidation Reduction Potential (mv)	Ag (ug/L) Total/Dissolved	Al (ug/L) Total/Dissolved	As (ug/L) Total/Dissolved	Ba (ug/L) Total/Dissolved
		WQB-7 Ground Water Human Health Standard	Groundwater											100		20	2000
PIPINICH 25-200-GW-1	10/11/95	Pipinich Residence	Groundwater	75	Granite Bedrock		7.0	7.4	238	291		7.0		/50	/200	/1	/200
PIPINICH 25-200-GW-1	05/01/96	Pipinich Residence	Groundwater	75	Granite Bedrock		6.6	7.1	353	329		7.5		/50	/200	/1	/200
HULL 25-200-GW-2	10/11/95	Hull Residence	Groundwater	155	Granite Bedrock		6.9	7.8	216	281		7.0		/50	/200	/1	/200
HULL 25-200-GW-2	05/01/96	Hull Residence	Groundwater	155	Granite Bedrock		6.0	7.3	294	285		6.0		/50	/200	/2	/200
M-VILLE 25-200-GW-3	10/11/95	Marysville House	Groundwater	28	Alluvium		6.8	7.3	163	212		6.0		/50	/200	/1	/200
HALL 25-200-GW-4	10/11/95	Hall Residence	Groundwater	105	Granite Bedrock		6.8	7.8	238	257		10.0		/50	/200	/1	/200
HALL 25-200-GW-4	05/01/96	Hall Residence	Groundwater	105	Granite Bedrock		7.2	7.3	181	216		8.0		/50	/200	/1	/200
25-200-PS-01	10/11/95	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge			0.27	8.1	8.3	256	237		8.0	+150	50/50	200/200	4/4	200/200
25-200-PS-01	02/08/96	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge			0.2	7.7	7.6	245	241		6.0		50/50	200/200	4/3	200/200
25-200-PS-01	05/01/96	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge			0.34	7.7	7.8	356	253		5.0		50/50	200/200	2/2	200/200
25-200-PS-01A	10/11/95	Bald Mountain (at black pipe draining adit to storage tank)	Adit Discharge			0.13	7.8	8.1	240	217		8.5	+195	50/50	200/200	5/4	200/200
25-200-PS-02	10/11/95	Drumlummon adit	Adit Discharge			0.1	7.7	8.0	605	528		11.0	-75	50/50	200/200	20/18	200/200
25-200-PS-02	02/08/96	Drumlummon adit	Adit Discharge			0.08	7.5	7.2	571	283		6.0		50/50	300/200	16/16	200/200
25-200-PS-02	05/01/96	Drumlummon adit	Adit Discharge			0.07	6.4	7.8	603	526		8.0		50/50	200/200	21/21	200/200
Adit #1	07/17/96	Belmont Mine adit	Adit Discharge									8.0		20	2800	3	100
Adit #18	07/17/96	Collapsed mine adit near the ski base area	Adit Discharge									5.0		20	200	2	100
Adit #2	07/17/96	Belmont Mine adit	Adit Discharge									5.0		20	200	2	100
25-024-AD1	6/23-24/94	Drumlummon Mill; adit discharge on WR4	Adit Discharge											0.14		34.9	128
H8	08/27/81	Maskelyne Tunnel discharge at culvert	Adit Discharge					7.0		449	4.4			<5	100	<5	100
H8	12/07/81	Maskelyne Tunnel discharge at culvert	Adit Discharge					7.3		557	5.9			<5	<100	33	200
H10	10/21/81	Obie adit discharge	Adit Discharge			0.009		7.2	287	269	0.56	4.8		<5/<5	<100/<100	<5/<5	<100/<100
TP #1	10/06/83	Tailings Pond Groundwater Monitoring System, Site #1	Groundwater														
TP #2	10/06/83	Tailings Pond Groundwater Monitoring System, Site #2	Groundwater					7.7		525							
TP #4	10/06/83	Tailings Pond Groundwater Monitoring System, Site #4	Groundwater					7.3		455							
TP #5	10/06/83	Tailings Pond Groundwater Monitoring System, Site #5	Groundwater					7.2		452							
TP #1 SEEP	11/16/83	Seep near Tailings Pond Groundwater Monitoring System, Site #1	Groundwater														
W-8	12/13/83	Robert O'Connell residence, Marysville	Groundwater					6.7		260	0.44				/<100		
W-22	12/13/83	Thomas residence, Marysville	Groundwater												/<100		
W-35	12/13/83	Goldsil Mining and Milling, Inc., mill office supply well	Groundwater												/<100		
E MILLER	10/21/81	Emma Miller Mine (shaft)	Groundwater					7.2		223	0.60			<5/<5	<100/<100	<5/<5	<100/<10
DRUMLUMMON	01/08/82	Drumlummon Mine No.1 shaft (28 ft. below water surface)	Groundwater					7.4		560	6.7			<5/<5	100/100	37/15	<100/<10
GW-1	9/2/87	Sump connecting four wells near the upstream tailings pond	Groundwater														
Station #5	11/29/76	Seep into Silver Creek between upper and lower tailings ponds	Groundwater														
Station #5	01/12/77	Seep into Silver Creek between upper and lower tailings ponds	Groundwater														
Station #5A	01/26/77	Seep into Silver Creek at lower tailings pond; western portion	Groundwater														
Station #5A	01/31/77	Seep into Silver Creek at lower tailings pond; western portion	Groundwater														
Station #5B	01/26/77	Seep into Silver Creek at lower tailings pond; eastern portion	Groundwater														
Station #5B	01/31/77	Seep into Silver Creek at lower tailings pond; eastern portion	Groundwater														

Note: WQB-7 standards for metals in groundwater are based upon the dissolved portion of the sample (after filtration through a 0.045 um membrane filter)

Table 2-11. Summary of Previous Silver Creek Drainage Groundwater and Adit Discharge Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	Cd (ug/L) Total/Dissolved	Co (ug/L)	Cr (ug/L) Total/Dissolved	Cu (ug/L) Total/Dissolved	Fe (ug/L) Total/Dissolved	Hg (ug/L) Total/Dissolved	Mn (ug/L) Total/Dissolved	Ni (ug/L) Total/Dissolved	Pb (ug/L) Total/Dissolved	Sb (ug/L) Total/Dissolved	Se (ug/L) Total/Dissolved	V (ug/L) Total/Dissolved	Zn (ug/L) Total/Dissolved	Ca (mg/L)	Mg (mg/L)	Na (mg/L)
		WQB-7 Ground Water Human Health Standard	Groundwater	5		100	1300	300	2	50	100	15	6	50		2000			
PIPINICH 25-200-GW-1	10/11/95	Pipinich Residence	Groundwater	/0.2		/10	/3	/50	/0.2	/15	/2	/1		/5		/50	48.0	6.0	5.0
PIPINICH 25-200-GW-1	05/01/96	Pipinich Residence	Groundwater	/0.2		/10	/5	/50	/0.2	/15	/2	/1		/5		/50	50.0	8.0	1.0
HULL 25-200-GW-2	10/11/95	Hull Residence	Groundwater	/0.2		/10	/28	/50	/0.2	/15	/2	/1		/5		/20	52.0	4.0	5.0
HULL 25-200-GW-2	05/01/96	Hull Residence	Groundwater	/0.2		/10	/16	/50	/0.2	/15	/2	/1		/5		/30	46.0	6.0	1.0
M-VILLE 25-200-GW-3	10/11/95	Marysville House	Groundwater	/0.2		/10	/50	/50	/0.2	/15	/2	/1		/5		/20	26.0	4.0	9.0
HALL 25-200-GW-4	10/11/95	Hall Residence	Groundwater	/0.2		/10	/10	/50	/0.2	/15	/2	/1		/5		/20	1.0	1.0	54.0
HALL 25-200-GW-4	05/01/96	Hall Residence	Groundwater	/0.2		/10	/5	/50	/0.2	/15	/2	/1		/5		/20	1.0	1.0	43.0
25-200-PS-01	10/11/95	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge	.2/.2		10/10	1/1	100/50	.2/.2	15/15	2/2	1/1		5/5		20/20	41.0	4.0	2.0
25-200-PS-01	02/08/96	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge	.2/.2		10/10	5/5	150/50	.2/.2	23/15	2/2	1/1		5/5		70/20	43.0	4.0	1.0
25-200-PS-01	05/01/96	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge	.2/.2		10/10	5/5	130/50	.2/.2	16/15	2/2	1/1		5/5		30/20	39.0	5.0	1.0
25-200-PS-01A	10/11/95	Bald Mountain (at black pipe draining adit to storage tank)	Adit Discharge	.2/.2		10/10	1/1	50/50	.2/.2	15/15	2/2	1/1		5/5		70/140	39.0	4.0	3.0
25-200-PS-02	10/11/95	Drumlummon adit	Adit Discharge	.2/.2		10/10	1/1	900/310	.2/.2	0	2/2	1/1		5/5		20/20	76.0	22.0	13.0
25-200-PS-02	02/08/96	Drumlummon adit	Adit Discharge	.2/.2		10/10	5/5	3050/340	.2/.2	0	2/2	1/1		5/5		70/20	77.0	23.0	2.0
25-200-PS-02	05/01/96	Drumlummon adit	Adit Discharge	.2/.2		10/10	5/5	1220/560	.2/.2	0	2/2	2/1		5/5		20/20	60.0	29.0	1.0
Adit #1	07/17/96	Belmont Mine adit	Adit Discharge			10	5	2330	0.2	100		1		5		90			
Adit #18	07/17/96	Collapsed mine adit near the ski base area	Adit Discharge			10	5	240	0.2	10		1		5		40			
Adit #2	07/17/96	Belmont Mine adit	Adit Discharge			10	5	60	0.2	10		1		5		70			
25-024-AD1	6/23-24/94	Drumlummon Mill; adit discharge on WR4	Adit Discharge	2.6	8.7	4.7	4.6	2140	0.11	1640	8.0	2.1	29.4			6.07			
H8	08/27/81	Maskelyne Tunnel discharge at culvert	Adit Discharge	<1		<20	<10	1160	<1	1700		<10		<5		150	84	22	8
H8	12/07/81	Maskelyne Tunnel discharge at culvert	Adit Discharge	<1		<20	10	1430	<.2	1860		<10		<5		10	80	24	8
H10	10/21/81	Obie adit discharge	Adit Discharge	<1/<1		<20/<20	<10/<10	60/<30	<.2/<.2	20/20		<10/<10		<5/<5		10/<10	53	6	2
TP #1	10/06/83	Tailings Pond Groundwater Monitoring System, Site #1	Groundwater																
TP #2	10/06/83	Tailings Pond Groundwater Monitoring System, Site #2	Groundwater						<.2								74	19	6
TP #4	10/06/83	Tailings Pond Groundwater Monitoring System, Site #4	Groundwater						<.2								72	18	7
TP #5	10/06/83	Tailings Pond Groundwater Monitoring System, Site #5	Groundwater						0.8								70	18	6
TP #1 SEEP	11/16/83	Seep near Tailings Pond Groundwater Monitoring System, Site #1	Groundwater																
W-8	12/13/83	Robert O'Connell residence, Marysville	Groundwater	/<10			/110	/<30	/<1	/<20	/<30	/<10		/<5	/<100	/10	39	7	3
W-22	12/13/83	Thomas residence, Marysville	Groundwater	/<10			/50	/<30	/<1	/<20	/<30	/<10		/<5	/<100	/20			
W-35	12/13/83	Goldsil Mining and Milling, Inc., mill office supply well	Groundwater	/<10			/<10	/3100	/<1	/60	/<30	/<10		/<5	/<100	/<10			
E MILLER	10/21/81	Emma Miller Mine (shaft)	Groundwater	<1/<1		<20/<20	10/10	60/<30	<.2/<.2	<20/<20		<10/<10		<5/<5		10/10	43	4	2
DRUMLUMMON	01/08/82	Drumlummon Mine No.1 shaft (28 ft. below water surface)	Groundwater	<1/<1		<20/<20	10/10	13900/60	<.2/<.2	1850/1510		50/<10		<5/<5		20/20	81	25	8
GW-1	9/2/87	Sump connecting four wells near the upstream tailings pond	Groundwater						1.06										
Station #5	11/29/76	Seep into Silver Creek between upper and lower tailings ponds	Groundwater																
Station #5	01/12/77	Seep into Silver Creek between upper and lower tailings ponds	Groundwater	<1			<10	50			<50					10			
Station #5A	01/26/77	Seep into Silver Creek at lower tailings pond; western portion	Groundwater	<1			<10	80			<50					<10			
Station #5A	01/31/77	Seep into Silver Creek at lower tailings pond; western portion	Groundwater																
Station #5B	01/26/77	Seep into Silver Creek at lower tailings pond; eastern portion	Groundwater	<1			<10	140			<50					<10			
Station #5B	01/31/77	Seep into Silver Creek at lower tailings pond; eastern portion	Groundwater																

Note: WQB-7 standards for metals in groundwater are based upon the dissolved portion of the sample (after filtration through a 0.045 um membrane filter)

Table 2-11. Summary of Previous Silver Creek Drainage Groundwater and Adit Discharge Chemistry Results

Sample Station	Sample Date	Sample Location	Medium	K (mg/L)	Hardness (mg $CaCO_3$/L)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Carbonate as CO_3 (mg/L)	Bicarbon-ate as HCO_3 (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	NO_3/NO_2-N (mg/L)	Total Cyanide (mg/L)	Source/Date
		WQB-7 Ground Water Human Health Standard	Groundwater										10000		
PIPINICH 25-200-GW-1	10/11/95	Pipinich Residence	Groundwater	1.0	145.0		195	0	167	137	1	19	0.62	0.005	Maxim, 1996
PIPINICH 25-200-GW-1	05/01/96	Pipinich Residence	Groundwater	2.0	158.0		197	0	173	142	2	19	0.98	0.005	Maxim, 1996
HULL 25-200-GW-2	10/11/95	Hull Residence	Groundwater	1.0	146.0		195	0	167	137	1	11	0.08	0.005	Maxim, 1996
HULL 25-200-GW-2	05/01/96	Hull Residence	Groundwater	2.0	140.0		176	0	167	137	2	10	0.13	0.005	Maxim, 1996
M-VILLE 25-200-GW-3	10/11/95	Marysville House	Groundwater	1.0	81.0		140	0	101	83	3	23	1.30	0.005	Maxim, 1996
HALL 25-200-GW-4	10/11/95	Hall Residence	Groundwater	1.0	7.0		175	0	104	85	7	24	3.48	0.005	Maxim, 1996
HALL 25-200-GW-4	05/01/96	Hall Residence	Groundwater	1.0	7.0		138	0	93	76	2	17	2.00	0.005	Maxim, 1996
25-200-PS-01	10/11/95	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge	1.0	119		160	0	129	106	2	19	1.22	0.005	Maxim, 1996
25-200-PS-01	02/08/96	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge	1.0	124		145	0	127	104	1	19	1.18	0.005	Maxim, 1996
25-200-PS-01	05/01/96	Bald Mountain (at culvert below ski area parking lot)	Adit Discharge	2.0	118		157	0	133	109	1	22		0.005	Maxim, 1996
25-200-PS-01A	10/11/95	Bald Mountain (at black pipe draining adit to storage tank)	Adit Discharge	1.0	114		142	0	123	101	1	15	0.78	0.014	Maxim, 1996
25-200-PS-02	10/11/95	Drumlummon adit	Adit Discharge	3.0	280		326	0	349	286	2	14	0.01	0.005	Maxim, 1996
25-200-PS-02	02/08/96	Drumlummon adit	Adit Discharge	5.0	287		306	0	339	278	2	12	0.19	0.005	Maxim, 1996
25-200-PS-02	05/01/96	Drumlummon adit	Adit Discharge	4.0	269		319	0	317	260	2	20	0.03	0.005	Maxim, 1996
Adit #1	07/17/96	Belmont Mine adit	Adit Discharge				171								Maxim, 1996
Adit #18	07/17/96	Collapsed mine adit near the ski base area	Adit Discharge				162								Maxim, 1996
Adit #2	07/17/96	Belmont Mine adit	Adit Discharge				142								Maxim, 1996
25-024-AD1	6/23-24/94	Drumlummon Mill; adit discharge on WR4	Adit Discharge		319		309				<5	24	<0.05		MDSL/AMRB, 1995
H8	08/27/81	Maskelyne Tunnel discharge at culvert	Adit Discharge	4	296	3	312	0	346	284	6	15			Goldsil Mining and Milling, Inc., 1984a
H8	12/07/81	Maskelyne Tunnel discharge at culvert	Adit Discharge	4	295	14	317	0	368	302	14	3			Goldsil Mining and Milling, Inc., 1984a
H10	10/21/81	Obie adit discharge	Adit Discharge	2	154	<1	172	0	169	139	23	2			Goldsil Mining and Milling, Inc., 1984a
TP #1	10/06/83	Tailings Pond Groundwater Monitoring System, Site #1	Groundwater											0.005	Hydrometrics, 1983
TP #2	10/06/83	Tailings Pond Groundwater Monitoring System, Site #2	Groundwater						288		2	26		<0.005	Hydrometrics, 1983
TP #4	10/06/83	Tailings Pond Groundwater Monitoring System, Site #4	Groundwater						272		2	26		<0.005	Hydrometrics, 1983
TP #5	10/06/83	Tailings Pond Groundwater Monitoring System, Site #5	Groundwater						269		2	25		<0.005	Hydrometrics, 1983
TP #1 SEEP	11/16/83	Seep near Tailings Pond Groundwater Monitoring System, Site #1	Groundwater											0.005	Hydrometrics, 1983
W-8	12/13/83	Robert O'Connell residence, Marysville	Groundwater	<1	128		142	0	133	109	1	24	0.14		Hydrometrics, 1983
W-22	12/13/83	Thomas residence, Marysville	Groundwater												Hydrometrics, 1983
W-35	12/13/83	Goldsil Mining and Milling, Inc., mill office supply well	Groundwater												Hydrometrics, 1983
E MILLER	10/21/81	Emma Miller Mine (shaft)	Groundwater	2	124	<1	142	0	135	110	22	1			Goldsil Mining and Milling, Inc., 1984a
DRUMLUMMON	01/08/82	Drumlummon Mine No.1 shaft (28 ft. below water surface)	Groundwater	5	302	13	314	0	372	305	2	8			Goldsil Mining and Milling, Inc., 1984a
GW-1	9/2/87	Sump connecting four wells near the upstream tailings pond	Groundwater											ND	MDHES, 1988
Station #5	11/29/76	Seep into Silver Creek between upper and lower tailings ponds	Groundwater											0.65	MT Dept. of Fish and Game, 1977
Station #5	01/12/77	Seep into Silver Creek between upper and lower tailings ponds	Groundwater											0.050	MT Dept. of Fish and Game, 1977
Station #5A	01/26/77	Seep into Silver Creek at lower tailings pond; western portion	Groundwater												MT Dept. of Fish and Game, 1977
Station #5A	01/31/77	Seep into Silver Creek at lower tailings pond; western portion	Groundwater											0.41	MT Dept. of Fish and Game, 1977
Station #5B	01/26/77	Seep into Silver Creek at lower tailings pond; eastern portion	Groundwater												MT Dept. of Fish and Game, 1977
Station #5B	01/31/77	Seep into Silver Creek at lower tailings pond; eastern portion	Groundwater											0.18	MT Dept. of Fish and Game, 1977

Note: WQB-7 standards for metals in groundwater are based upon the dissolved portion of the sample (after filtration through a 0.045 um membrane filter)

3.0 LAND OWNERSHIP SUMMARY

Land ownership in the areas adjacent to Silver Creek was compiled by MWCB and Olympus. MWCB send out letters and access agreements to potentially affected land owners prior to initiating field sampling. The majority of land owners responded and granted access to their property for characterization activities. Appendix A contains copies of the signed access agreements. Figures 3-1a through 3-c show the land parcels and owners within the Phase II site characterization project area. Table 3-1 provides a summary of all land owners (Phase I and Phase II project areas) who signed and returned access agreements to the MWCB.

TABLE 3-1 SUMMARY OF LAND OWNER ACCESS AGREEMENTS

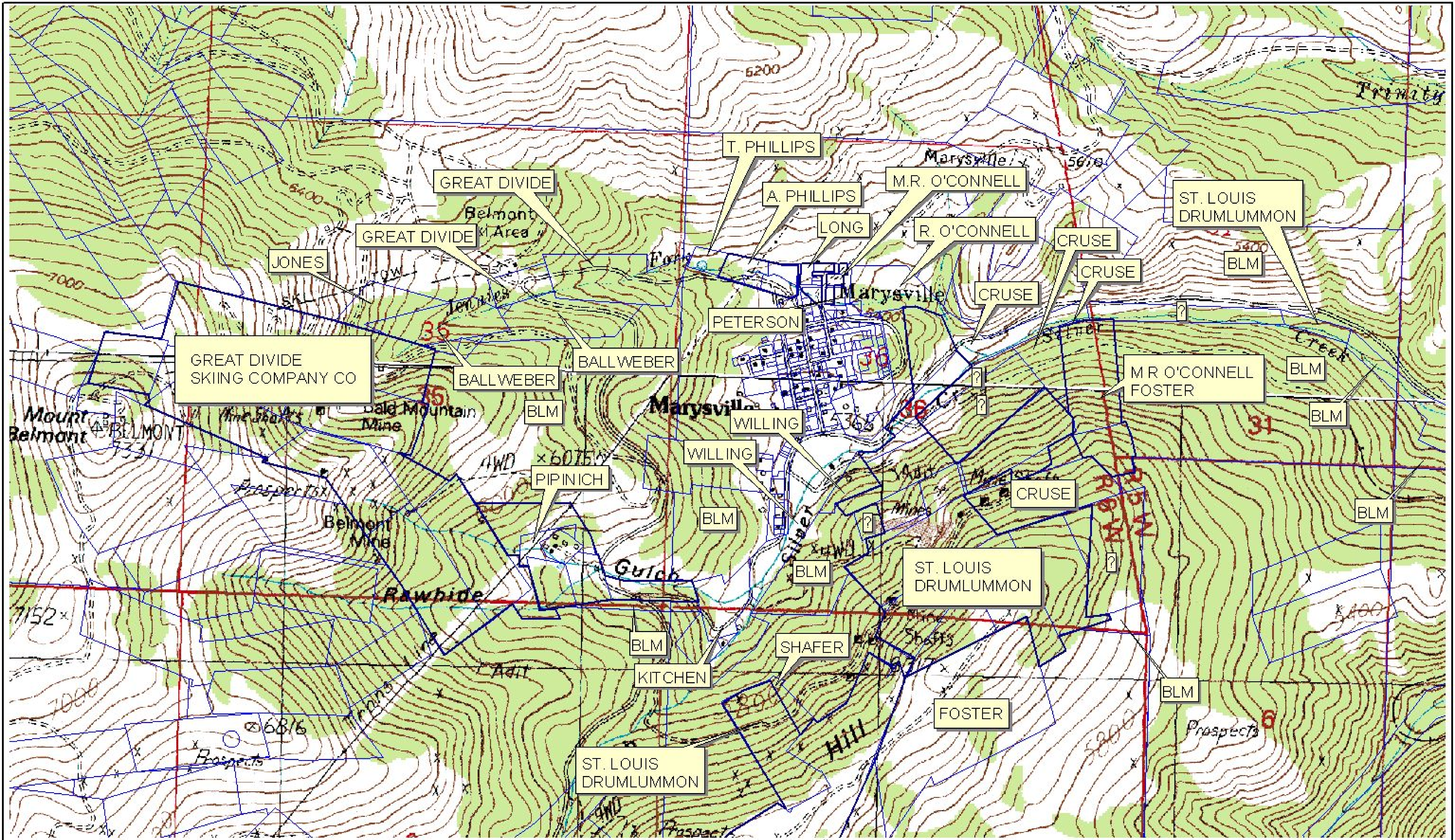
Owner Name	Owner Name
Anderson, Jerry	Marcucci, Michael and Andrea Sue
Anderson, H. Howard	Mares, Kenneth R.
Baker, Gary & Ann I.	O'Connell, Mary Ruth
Carson, David	O'Connell, Rick, ETAL
Connolly, Michael and Sarah	Phillips, Andre
Eskildsen, Max and Barbara	St. Louis Drumlummon Mines, Inc.
Farnam, Jill and Jay C. Lyndes	Settle Ranch Co.
Foster, Earle C. & Rhea L.	Shafer, Clem
Gebhardt, Judith A.	Shunick, Margaret A. Shunick-Duezabou
Great Divide Skiing Co.	Stevens, Jerry P. & Rachel M.
Gunnels, Martalee & Walter A.	Talley, Alton Ray & Mary J.
John, Theresa A.	Thomas Cruse Mining & Development
Jones, Alan / Valdean	Willing, William C.
Long, Cheri Lyn	

4.0 FIELD ACTIVITIES

The objective of the Silver Creek Drainage Project Phase II Detailed Site Characterization is to collect sufficient data from the site to perform a risk assessment and detailed analysis of reclamation alternatives. The principal techniques used for data acquisition in this site investigation were drilling, backhoe test pits, field mapping, soil and groundwater sampling. Samples were collected using standard operating procedures that are contained in the Field Sampling Plan (DEQ-MWCB/Olympus, 2002a) and were analyzed according to the Laboratory Analytical Plan (DEQ-MWCB/Olympus, 2002d). Analytical data were evaluated for quality assurance according to the Quality Assurance Project Plan (DEQ-MWCB/Olympus, 2002e).

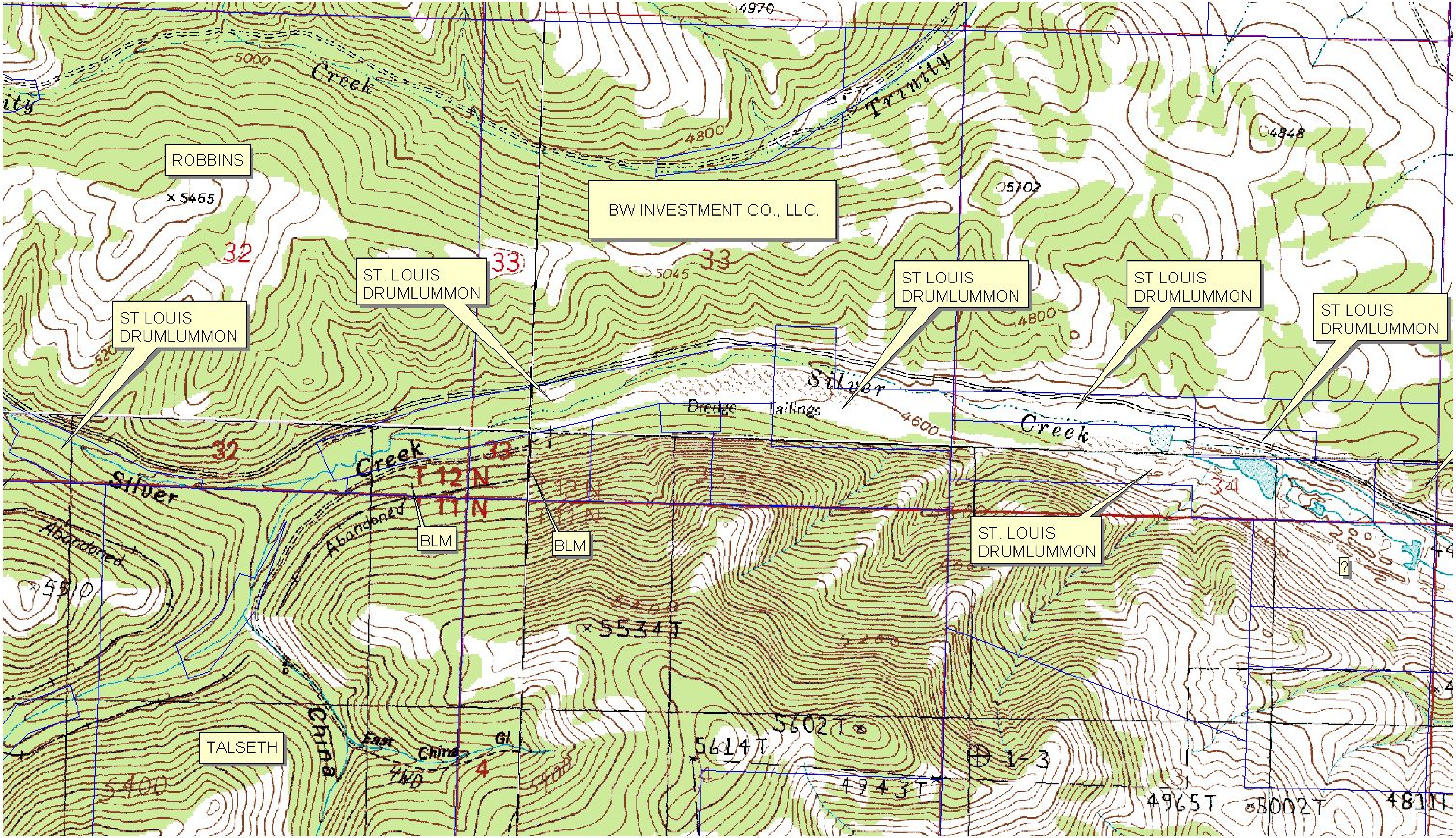
Phase II site characterization field activities were conducted during the period August 29, 2002 through December 4, 2002. Phase II site characterization activities focused on:

- Background soil characterization;
- Mill tailings characterization (mapping, volume estimate, geology, metals/pH chemistry, acid-base accounting and toxicity characteristic leaching procedure (TCLP);



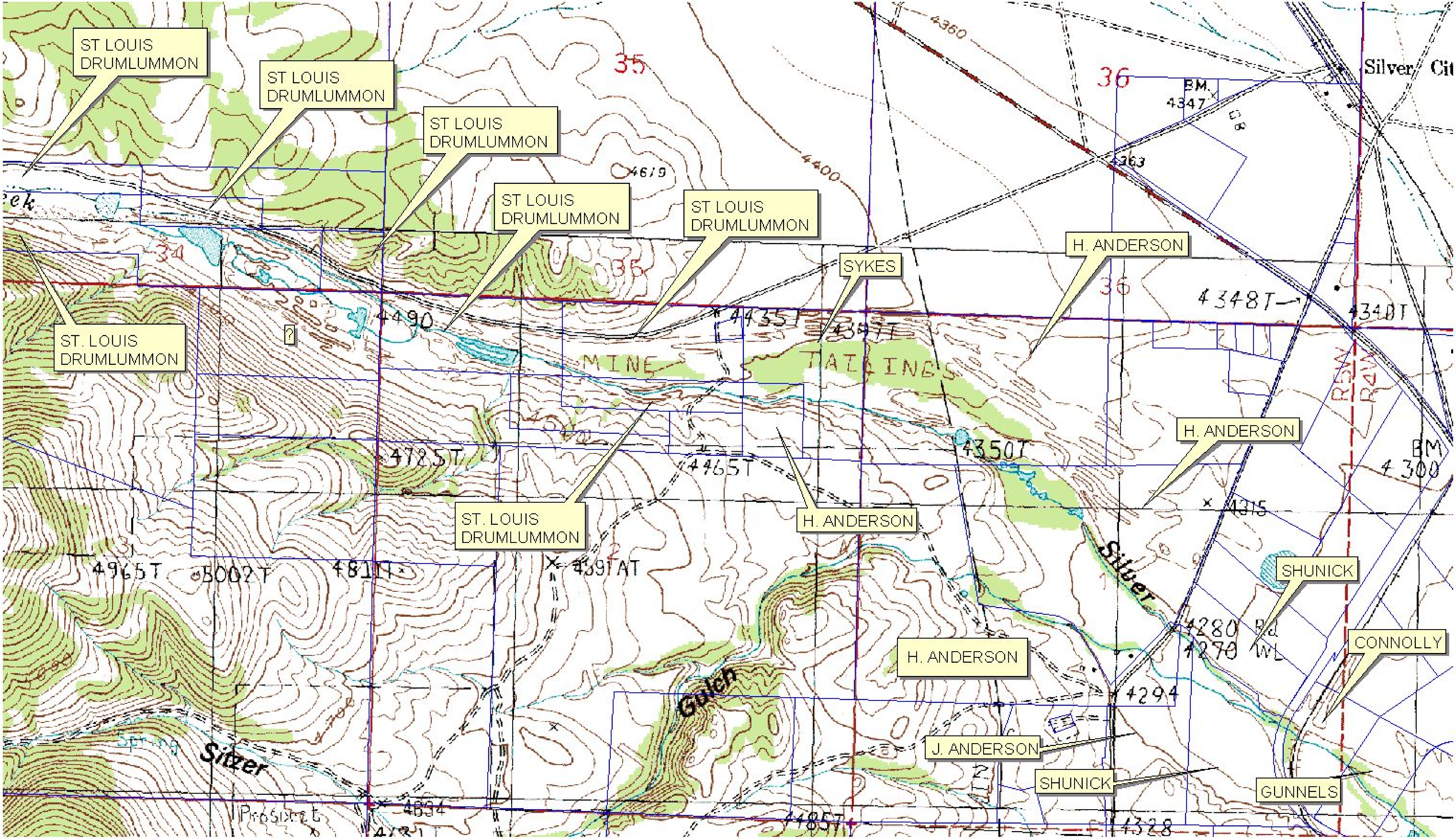
Olympus Technical Services, Inc.

Figure 3-1a. Silver Creek Drainage Project Land Ownership Map



Olympus Technical Services, Inc.

Figure 3-1b. Silver Creek Drainage Project Land Ownership Map



Olympus Technical Services, Inc.

Figure 3-1c. Silver Creek Drainage Project Land Ownership Map

- Waste rock characterization (mapping, volume estimate, geology, metals/pH chemistry, acid-base accounting and TCLP);
- Groundwater characterization (shallow aquifer geology, water table, and water quality);
- Assessment of airborne particulate emissions;
- Assessment of physical hazards;
- Summary of contaminant exposure pathways; and
- Potential repository site investigation.

The following sections summarize the results of the Phase II site characterization activities.

5.0 BACKGROUND SOIL CHARACTERIZATION

Four background soil samples were collected from below the Goldsil millsite area according to the Phase I FSP (MWCB/Olympus, 2002b). In addition, two background soil samples were collected from above the Goldsil millsite area according to the Phase II FSP (MWCB/Olympus, 2002a). The sample locations are shown on Figure 5-1. The sample locations were selected to provide representative coverage of the Silver Creek Drainage Project Area. The samples were collected from outside of known waste areas and areas of other disturbances.

Background soil samples were screened for a multi-element suite using a portable x-ray fluorescence (XRF) analyzer and the same samples were analyzed at Energy Laboratories, Inc. for paste pH, As, Cd, Cu, Hg, Pb and Zn. The two samples collected according to the Phase II FSP from above the Goldsil millsite were also analyzed for Ag, Ba, Cr, Fe, Mn, Ni and Sb. The laboratory analytical results are presented in Table 5-1. XRF analytical results are contained in Appendix B and laboratory analytical data and chain-of-custody are contained in Appendix C.

Laboratory measured background soil pH ranges from 7.1 to 7.6 standard units (SU), with a mean of 7.4 SU. Cadmium, mercury and silver were below detection limits. Arsenic concentrations ranged from <5 to 46 mg/Kg with a mean of 25.2. Copper concentrations ranged from 16 to 105 mg/Kg with a mean of 34.2 mg/Kg. Lead concentrations ranged from 7 to 15 mg/Kg with a mean of 11.3 mg/Kg. Zinc concentrations ranged from 28 to 112 mg/Kg with a mean of 68.8 mg/Kg. Barium, chromium, iron, manganese and nickel had mean concentrations of 145 mg/Kg, 12 mg/Kg, 13,700 mg/Kg, 504 mg/Kg and 9 mg/Kg, respectively. Antimony concentrations were below detection limits (<5 mg/Kg) in one sample and 7 mg/Kg in the other sample.

Background soil samples were collected by Pioneer as part of the Hazardous Materials Inventories for the Bald Mountain mine, Belmont mine, Drumlummon mine and millsite and Goldsil millsite. The background soil samples referenced in the Hazardous Materials Inventories for these sites were collected at the Big Ox, Drumlummon and Empire mine sites. A summary of the laboratory chemistry results of these background soils is presented in Table 5-1. Pioneer's background soil data is generally in the same range as the background soil data from this project. Cadmium and mercury were below detection limits in both data sets. The mean arsenic and copper concentrations have less than 10 percent relative percent differences between the two data sets. Both lead and zinc are higher in Pioneer's background soil samples, although the overall concentrations are relatively low.

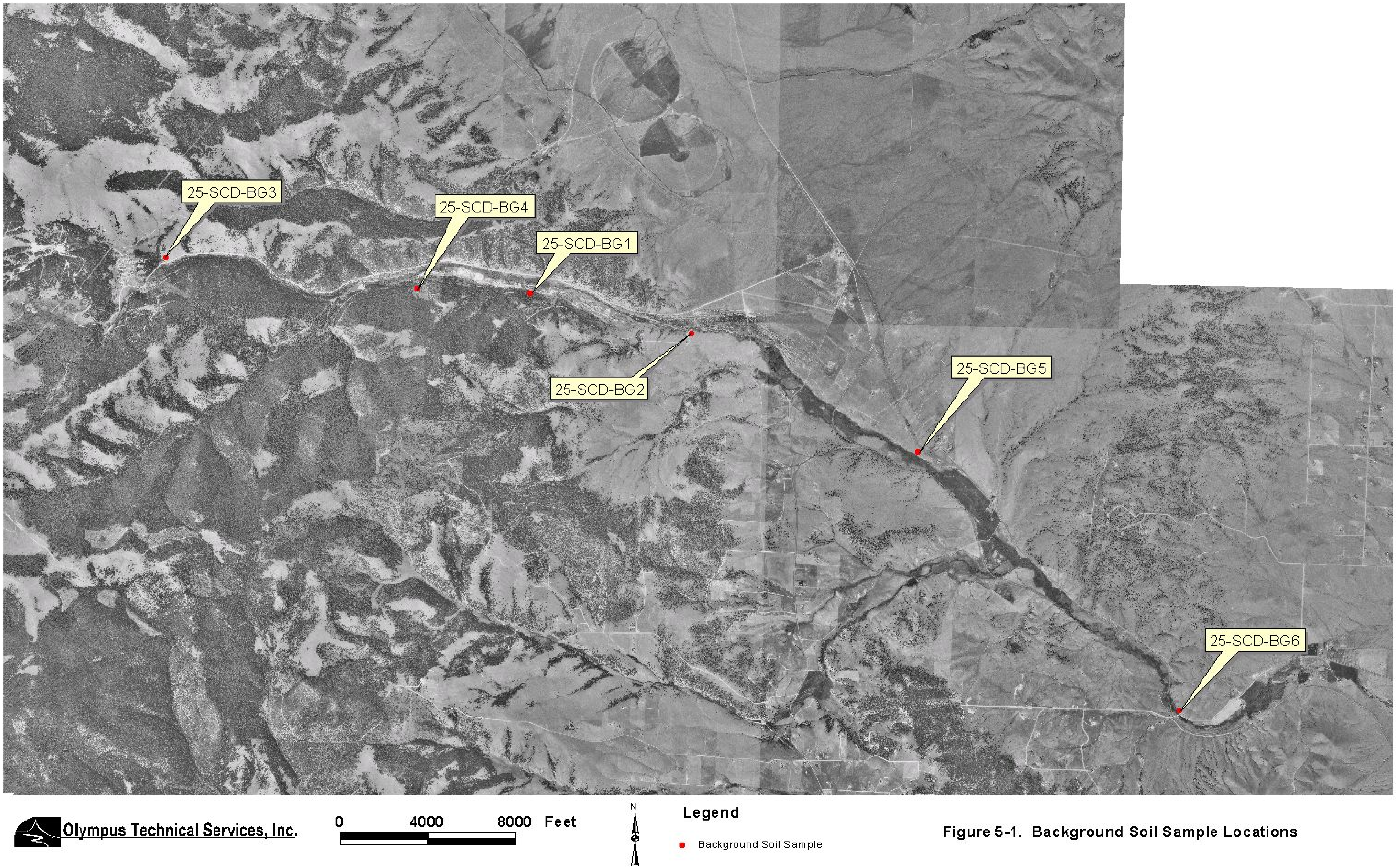


Figure 5-1. Background Soil Sample Locations

Table 5-1. Background Soil Laboratory Results

Sample ID	Paste pH	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Pb (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
25-SCD-BG1	7.1		46		<1		18		15	<1				70
25-SCD-BG2	7.6		46		<1		19		9	<1				28
25-SCD-BG3	7.3	<5	<5	164	<1	15	20	14000	7	<1	568	9	<5	57
25-SCD-BG4	7.3	<5	22	126	<1	9	16	13400	13	<1	440	9	7	56
25-SCD-BG5	7.6		6		<1		27		9	<1				112
25-SCD-BG6	7.3		6		<1		105		15	<1				90
Maximum	7.6	<5	46	164	<1	15	105	14000	15	<1	568	9	7	112
Minimum	7.1	<5	6	126	<1	9	16	13400	7	<1	440	9	<5	28
Mean	7.37		21.4	145.0		12.0	34.2	13700.0	11.3		504.0	9.0	4.8	68.8
n	6	2	6	2	6	2	6	2	6	6	2	2	2	6

LEGEND

25-SCD-BG1	Sample site on south hillside between Goldsil Millsite and Upper Pond
25-SCD-BG2	Sample site on south hillside east of Little Falcon Road
25-SCD-BG3	Sample site north of Silver Creek on ridge east of Jennies Fork
25-SCD-BG4	Sample site west of Argo millsite on hillside just above old railbed
25-SCD-BG5	Sample site on plateau on northside of Silver Creek near Silver Fox Court
25-SCD-BG6	Sample site on ridge east of Silver Creek and north of Silver Creek Road

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

Pioneer Background Samples

Sample ID	Paste pH	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Pb (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
Big Ox Mine			25	650	<0.4	10.7	32.6	14700	28	0.187	662	14	<3	75
Drumlummon		<0.7	8.2	312	<0.6	15	12.1	14500	<8.56	<0.03	454	9.8	<6.9	58.1
Empire Mine			38	239	<0.5	14.1	49.7	19500	80	0.122	1000	<15	<4	153
Mean			23.73	400		13.27	31.47	16233.33	54.0	0.1545	705.3	11.9		95.4
Maximim			38	650		15	49.7	19500	80	0.187	1000	14		153

6.0 MINE/MILL WASTE CHARACTERIZATION

6.1 MILL TAILINGS

As a result of previous studies and the current work, nine mill tailings areas have been identified and these include: Drumlummon tailings pile (DT), Goldsil tailings pile (GT), the Goldsil mill tailings area (GM), Drumlummon millsite area tailings piles (TP1, TP2 and TP3), the Upper Pond tailings area (UP), Middle Pond tailings area (MP), and Lower Pond tailings area (LP). The tailings piles were investigated using one or more of the following methods: backhoe test pits, hand auger/shovel pits, geoprobe drilling, chemical analysis of samples and field observations. Test pit and drill hole logs for the mill tailings areas are summarized in Appendix D.

Representative samples of mill tailings were collected by one or more of the following methods: geoprobe drill cores, vertical channel samples taken from test pit walls, grab samples collected from test pit excavation stockpiles and samples collected via hand auger or shovel. Individual samples were collected based on similar geologic characteristics. Samples were collected with stainless steel tools using a deionized (DI) water rinse, dilute HNO_3 rinse followed by a final DI rinse. All samples collected during the tailings investigation were analyzed by X-ray fluorescence spectrometry (XRF) for a multi-element suite. A Spectrace 9000 portable XRF analyzer was used to provide qualitative to semi-quantitative analyses for a 26-element suite including chromium VI (CrHI), potassium (K), calcium (Ca), titanium (Ti), chromium III (CrLo), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), selenium (Se), strontium (Sr), molybdenum (Mo), mercury (Hg), lead (Pb), rubidium (Rb), cadmium (Cd), tin (Sn), antimony (Sb), barium (Ba), silver (Ag), uranium (U), and thorium (Th). The XRF instrument employed three radioisotope sources including Fe-55, Cd-109 and Am-241 and each sample was radiated for 100 counts per second (cps) using the Fe-55, 400 cps with Cd-109, and 100 cps for Am-241. The XRF analytical results and basic univariate statistics for samples collected in each of the tailings piles are contained in Appendix B.

Tailings piles are generally created by depositing sediment slurry into a basin setting. Thus tailings piles commonly exhibit a stratigraphy that is similar to undisturbed sedimentary rocks with vertical layering and lateral facies changes. Chemical changes in the pile are directly related to changes in the chemistry of the orebody and/or changes in the metallurgical processing method. Some of the tailings piles in the Silver Creek Drainage Project are further complicated by the fact that they have been disturbed and reprocessed after initial deposition.

To evaluate the chemistry of the tailings piles, representative composite samples were collected in order to control the number of samples submitted for quantitative laboratory analyses. Composite samples of the tailings were made from two or more test pits, hand auger/shovel or geoprobe drill intervals based on the evaluation of the geology of the pile and XRF sample results. Composite samples collected from the tailings piles were analyzed at Energy Laboratories, Inc. in Billings, MT for the following target analyte list: pH, Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Zn and total cyanide. Some of the tailings samples that were collected during Phase I site characterization were analyzed for a lesser number of parameters including: pH, As, Cd, Cu Hg, Pb, Zn and total cyanide. The analytical methods are summarized in the Phase II Field Sampling Plan (MDEQ-MWCB/Olympus, 2002a). The tailings analytical chemistry results are summarized in Table 6-1 and the laboratory data sheets and chain-of-custody forms are contained in Appendix C. A comparison of mill tailings qualitative to semi-

TABLE 6-1. Laboratory Chemistry Results For Mill Tailings and Selected Subgrade Native Soils

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Pb (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)	Total Cyanide (mg/Kg)	Comments
Drumlummon Tailings																
25-024-TP-1	7.7	14	10	51	<1	11	67	9100	73	1	512	7	<5	110	<0.5	Composite of DT-4 0-5.0;DT-12 4.2-6.4;DT-15 4.7-6.6
25-024-TP-2	7.9	21	14	56	<1	7	79	7860	45	<1	402	5	7	115	<0.5	Composite of DT-1 7.8-9.5;DT-10 3.7-10.0
25-024-TP-3	7.9	10	<5	40	<1	8	23	6380	37	<1	477	<5	<5	64	<0.5	Composite of DT-2 0-4.0;DT-8 0-5.8;DT-12 0-4.2:DT-15 0-4.7
25-024-TP-4	7.9	20	20	35	<1	<5	74	7360	79	1	414	<5	8	124	<0.5	Composite of DT-1 4.8-7.8;DT-3 3.7-7.4;DT-5 0-8.9
25-024-TP-5	7.9	17	12	55	<1	7	69	7720	38	<1	386	<5	5	100	<0.5	Duplicate split of 25-024-TP-2
Maximum	7.9	21	20	56	<1	11	79	9100	79	1	512	7	8	124	<0.5	
Minimum	7.7	10	10	35	<1	7	23	6380	37	<1	386	<5	<5	64	<0.5	
Mean	7.9	16.4	11.7	47.4		7.1	62.4	7684.0	54.4		438.2		5.0	102.6		
No. Samples	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Goldsil Tailings																
25-365-TP-1	8.1	15	22	42	2	6	122	6470	122	18	551	<5	16	237	10.9	Composite of GM-2 0-0.6;GM-4 0-2.1;GM-6 0-1.8;GM-8 0-4.4
25-365-TP-2	8.1		30		3		157		158	22				376	21.1	Composite of GM-3 0-2.1;GM-5 0-2.4;GM-7 0-2.3;GM-9 0-1.5
25-365-TP-3	7.9		34		3		185		197	66				385	0.6	Composite of GM-12 0-10;GM-13 0-11.5;GM-14 0-13.5;GM-15 0-14.6
25-365-TP-4	7.6		39		3		180		201	60				396	<0.5	Composite of GM-18 0-13.8;GM-22 0-12.4;GM-26 0-3.8
25-365-TP-5	7.9		38		3		188		207	66				414	<0.5	Duplicate split of 25-365-TP-3
25-365-TP-6	8.0	9	28	44	4	<5	130	6680	154	25	714	<5	16	308	<0.5	Composite of GT-6 0-7.1;GT-7 0-9.0;GT-9 0-8.4
25-365-TP-7	7.9	14	27	35	4	<5	114	6660	137	25	621	<5	17	260	<0.5	Composite of GT-10 0-6.7;GT-13 0-7.8
25-365-TP-8	7.9		33		4		154		160	43				364	0.8	Composite of GT-2 0-16.4;GT-3 0-16.8
25-365-TP-9	7.8		37		4		173		201	57				386	0.7	Composite of GT-14 0-6.6;GT-15 0-5.0
25-365-TP-10	8.0		31		4		154		153	36				299	<0.5	Composite of GT16 0-15.2;GT-17 0-14.6;GT-20 0-15.2
25-365-TP-11	7.6	12	40	70	3	5	220	8790	242	86	830	<5	15	507	2.8	Composite of GTDH-1 0-5;GTDH-6 0-5;GTDH-3 0-5
25-365-TP-12	7.7	13	45	75	3	6	240	9720	268	96	889	5	15	557	6.8	Composite of GTDH-2 0-5;GTDH-4 0-5;GTDH-5 0-5
25-365-TP-13	8.0	15	32	49	3	<5	190	6160	187	57	788	<5	12	330	0.9	Composite of GTDH-1 15-20;GTDH-6 15-20;GTDH-3 15-20
25-365-TP-14	7.9	20	31	51	3	<5	187	6630	208	84	789	<5	15	374	2.3	Composite of GTDH-2 15-20;GTDH-4 15-20;GTDH-5 15-20
25-365-TP-15	7.9	32	26	44	3	<5	190	4970	177	48	593	<5	17	300	3.1	Composite of GTDH-1 29-34;GTDH-6 30-35;GTDH-3 30-35
25-365-TP-16	7.8	43	29	44	3	<5	199	5690	210	53	685	<5	15	357	10.2	Composite of GTDH-2 30-34;GTDH-4 30-33.1;GTDH-5 30-35
25-365-TP-17	8.0	18	24	35	2	<5	144	5490	143	28	553	<5	13	271	1.0	Composite of GTDH-7 5-10;GTDH-8 5-10;GTDH-9 5-10
25-365-TP-18	8.0	18	26	49	2	<5	133	5810	137	39	629	<5	14	257	0.6	Composite of GTDH-7 15-19.4;GTDH-8 15-20;GTDH-9 15-20
25-365-TP-19	7.9	22	33	43	3	<5	192	6210	192	54	751	<5	15	353	2.9	Duplicate split of 25-365-TP-13
Maximum	8.1	43	45	75	4	6	240	9720	268	96	889		17	557	21.1	
Minimum	7.6	9	22	35	2	<5	114	4970	122	18	551		12	237	<0.5	
Mean	7.9	19.3	31.8	48.4	3.1		171.2	6606.7	181.8	50.7	699.4		15.0	354.3	3.5	
No. Samples	19	12	19	12	19	12	19	12	19	19	12	12	12	19	19	
Goldsil Tailings Subgrade Native Soils																
25-365-SS-1	7.5		54		<1		24		20	2				81	2.4	Composite of GM-3 2.1-3.1;GM-5 2.4-3.4;GM-7 2.3-3.3;GM-9 1.5-2.5
25-365-SS-2	7.8		26		<1		16		11	<1				57	<0.5	Split of GM-27
25-365-SS-3	7.4		19		3		34		15	6				73	0.8	Composite of GT-1 1.2-3.6;GT-4 2.8-5.0
25-365-SS-4	7.6		28		<1		62		16	6				69	7.9	Composite of GTDH-1 42.55-43.55;GTDH-6 42.65-44.0;GTDH-3 37.75-38.85;GTDH-4 33.1-34.0
Drumlummon Millsite Tailings																
25-SCD-TP-1	7.9		41		<2		195		173	1				281	1.7	Composite of clayey tailings from TP1-1
25-SCD-TP-2	8.0		32		<2		62		115	1				105	1.8	Composite of silty sand tailings from TP1-2 and TP1-5
25-SCD-TP-3	7.3		21		<2		64		74	9				78	<0.2	Composite of fine sand tailings from TP2-1 and TP2-1
25-SCD-TP-4	7.7		18		<2		53		77	9				104	<0.2	Composite of sandy tailings from TP3-2 and TP-3-3
25-024-DMTP1	8.2	8	28	88	<1	11	114	10600	147	<1	474	<5	10	335	24.8	Tailings from Drumlummon Mill foundation
Maximum	8.2		41		<2		195		173	9				335	24.8	
Minimum	7.3		18		<2		53		74	<1				78	<0.2	
Mean	7.82		28.0				97.6		117.2	4.1				181	5.70	
No. Samples	5		5		5		5		5	5				5	5	

TABLE 6-1. Laboratory Chemistry Results For Mill Tailings and Selected Subgrade Native Soils

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Pb (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)	Total Cyanide (mg/Kg)	Comments
Upper Pond Tailings Area																
25-SCD-TP-7	8.0		27		3		164		163	32				334	0.5	Composite of UP6 0-5;UP7 0-3.8:LP8 0-1.4
25-SCD-TP-8	7.9		54		4		301		331	140				686	1.0	Composite of UP2 5.5-7;UP3 5.1-7.4:UP4 0-6.1;UP8 9.4-10.5
Maximum	8.0		54		4		301		331	140				686	1	
Minimum	7.9		27		3		164		163	32				334	0.5	
Mean	8.0		40.5		3.5		232.5		247.0	86.0				510.0	0.8	
No. Samples	2		2		2		2		2	2				2	2	
Upper Pond Area Subgrade Native Soil																
25-SCD-TP-9	7.7		31		<1		84		50	25				90	<0.5	Composite of UP1 3.9.4.9;UP2 7-8:UP4 6.1-7.8;UP7 3.8-4.8
Middle Pond Area Tailings																
25-SCD-TP-10	7.4		22		3		98		104	16				215	4.1	Composite of MP-2 0-5.8;MP-6 0-4.3;MP-7B 0-3.6;MP-9 0-3.4
25-SCD-TP-11	7.7		25		<1		79		78	7				166	23.9	Composite of MP-3 6.5-7.4;MP-7B 3.6-4.6;MP-9 4.3-6.5
25-SCD-TP-12	7.7		20		2		107		114	26				226	5.9	Composite of MP-15 0-4.7;MP-16 0-2.5;MP-20 0-3.7
25-SCD-TP-13	7.7		27		2		131		147	26				262	4.9	Composite of MP-13 0-2.8;MP-16 2.5-4.2
Maximum	7.7		27		3		131		147	26				262	23.9	
Minimum	7.4		20		<1		79		78	7				166	4.1	
Mean	7.6		23.5		1.9		103.8		110.8	18.8				217.3	9.7	
No. Samples	4		4		4		4		4	4				4	4	
Middle Pond Area Subgrade Native Soil																
25-SCD-SS-1	7.8		49		<1		21		14	<1				51	2.1	Composite of MP-3 7.4-7.9;MP-6 5.2-6.0;MP-9 6.5-7.5 (native soil)
Lower Pond Area Tailings																
25-SCD-TP-5	8.0		27		2		135		132	37				280	5.0	Composite of LP1 0-5;LP2 0-5:LP4 0-5;LP6 2.5-5
25-SCD-TP-6	8.1		29		2		115		107	27				231	2.0	Composite of LP1 9-14;LP4 5-10:LP6 5-8
Maximum	8.1		29		2		135		132	37				280	5.0	
Minimum	8.0		27		2		115		107	27				231	2.0	
Mean	8.1		28.0		2.0		125.0		119.5	32.0				255.5	3.5	
No. Samples	2		2		2		2		2	2				2	2	

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation quantitative XRF and quantitative laboratory analytical results was made for lead, zinc, copper, and mercury. In addition, combined copper, lead and zinc results were statistically investigated. The comparative results indicate that lead and zinc data sets show statistically significant correlation coefficients of 0.90 and 0.94, respectively. Copper and mercury data sets are not well correlated with coefficients of 0.69 and 0.77. Base metals in the tailings are generally low with combined copper, lead and zinc concentrations commonly less than 1,000 mg/Kg. The combined copper, lead and zinc XRF and laboratory data sets show a strong correlation coefficient of 0.94, thereby suggesting that XRF results are representative of the combined total metal concentration for these selected base metal elements in the tailings.

The following sections describe results of investigations pertaining to volume estimates, geology, pH/metals chemistry, acid-base accounting and hazardous waste characterization for the mill tailings areas in the Silver Creek drainage.

6.1.1 Drumlummon Tailings

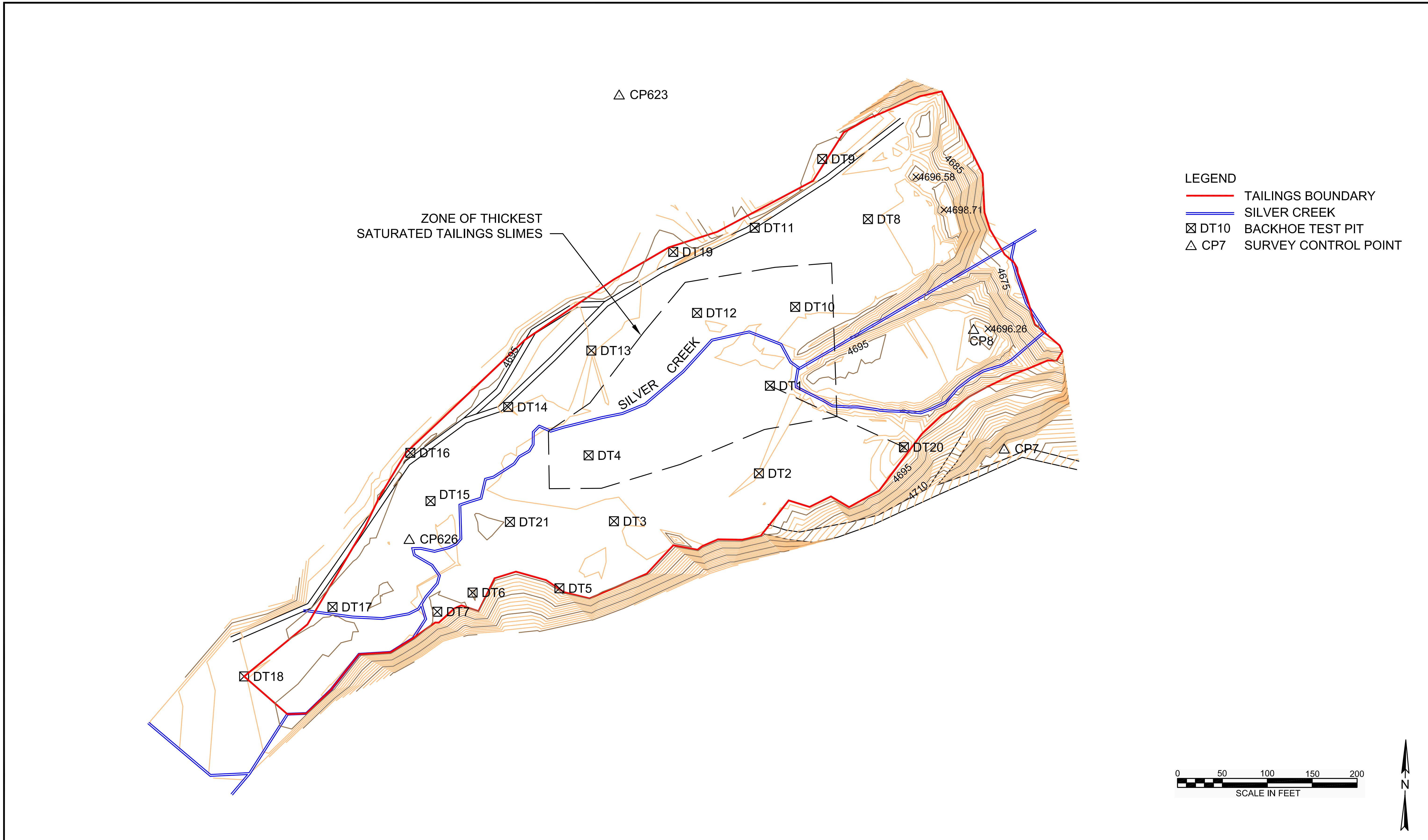
The Drumlummon tailings pile is located in the SE¼ Section 32, Township 12 North and Range 5 West, Montana Principal Meridian (Figure 1-1). The tailings pile occurs within the Silver Creek drainage and its floodplain. Because of past tailings erosion problems, Silver Creek has been diverted into rock-lined channels in the area of the breached tailings dam to minimize sedimentation impacts from storm water and snowmelt runoff events. With the exception of the areas near the breached tailings dam, the tailings pile is generally well vegetated with grasses and other shrubs and trees including willows. In the dam area, the Silver Creek channel is lined and the tailings pile is capped with rock to control erosion of tailings sediment.

6.1.1.1 Tailings Volume Estimate

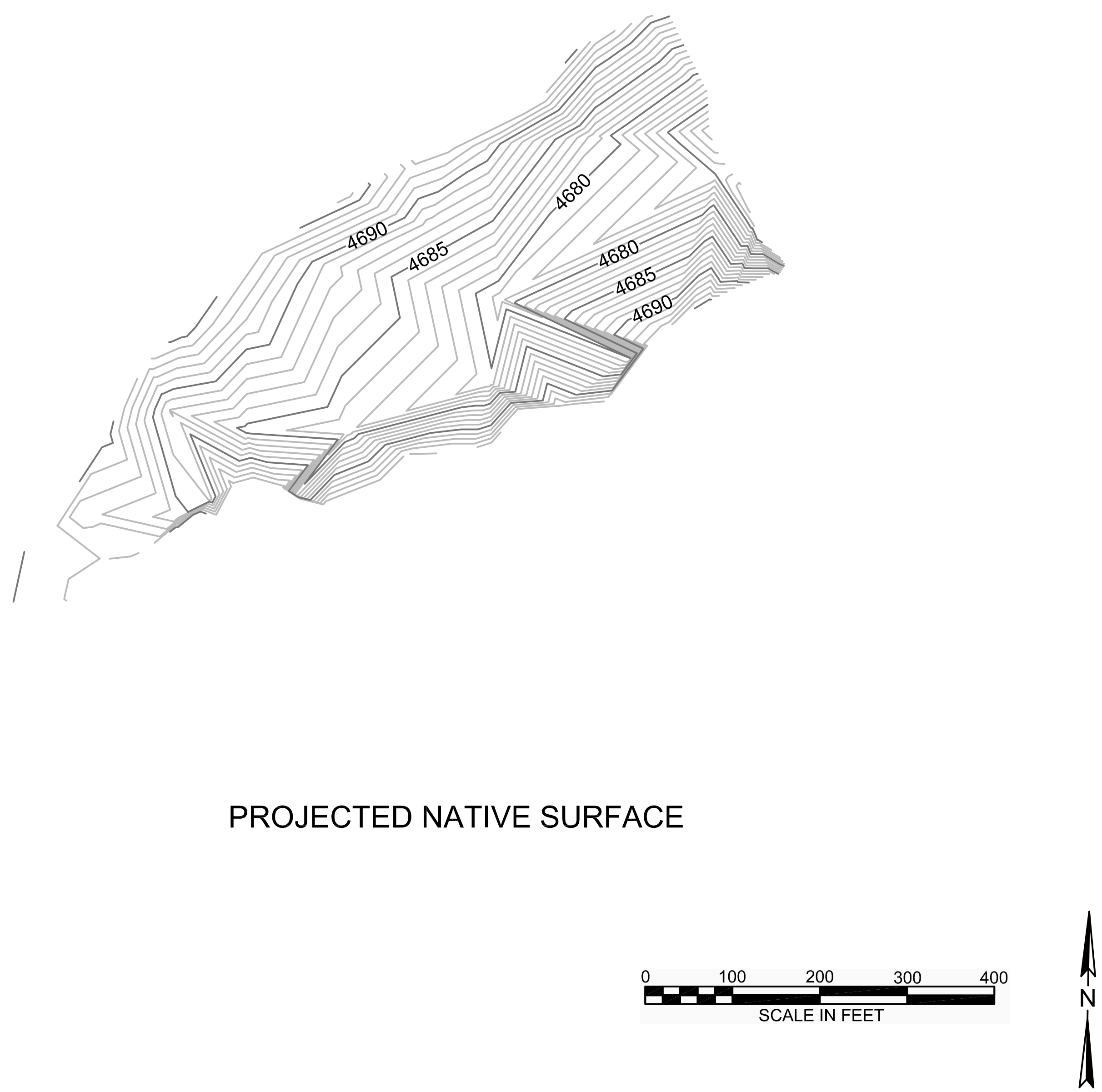
The Drumlummon tailings volume was estimated using the detailed topographic survey of the tailings surface and the backhoe test pit data (Figure 6-1). The test pit data were used to evaluate the depth of the tailings and the elevation of the native surface. The native surface elevations were plotted and the native surface below the tailings was reconstructed into a surface model that fit the test pit data and topography surrounding the tailings (Figure 6-2). Eagle Point Civil/Survey 2002 software was used to triangulate and contour the native surface model. The contoured native surface was then evaluated to ensure that it was a reasonable representation of what the pre-tailings deposition surface may have looked like.

Eagle Point calculates volumes using a prismoidal method. The prismoidal method uses a form of finite element analysis and is a true volume calculation, rather than an averaging method. The method forms a series of prisms between two surfaces (such as the existing tailings surface and the projected native surface) and calculates the volume of each prism. The total volume is calculated by summing the volume of the individual prisms.

The estimated volume of the Drumlummon tailings pile is 59,780 cubic yards (Table 6-2). The tailings plan area is 5.45 acres and the average tailings depth is 6.8 feet. The maximum tailings thickness measured in the test pits was 15 feet. A total of 21 backhoe test pits were excavated in the Drumlummon tailings.



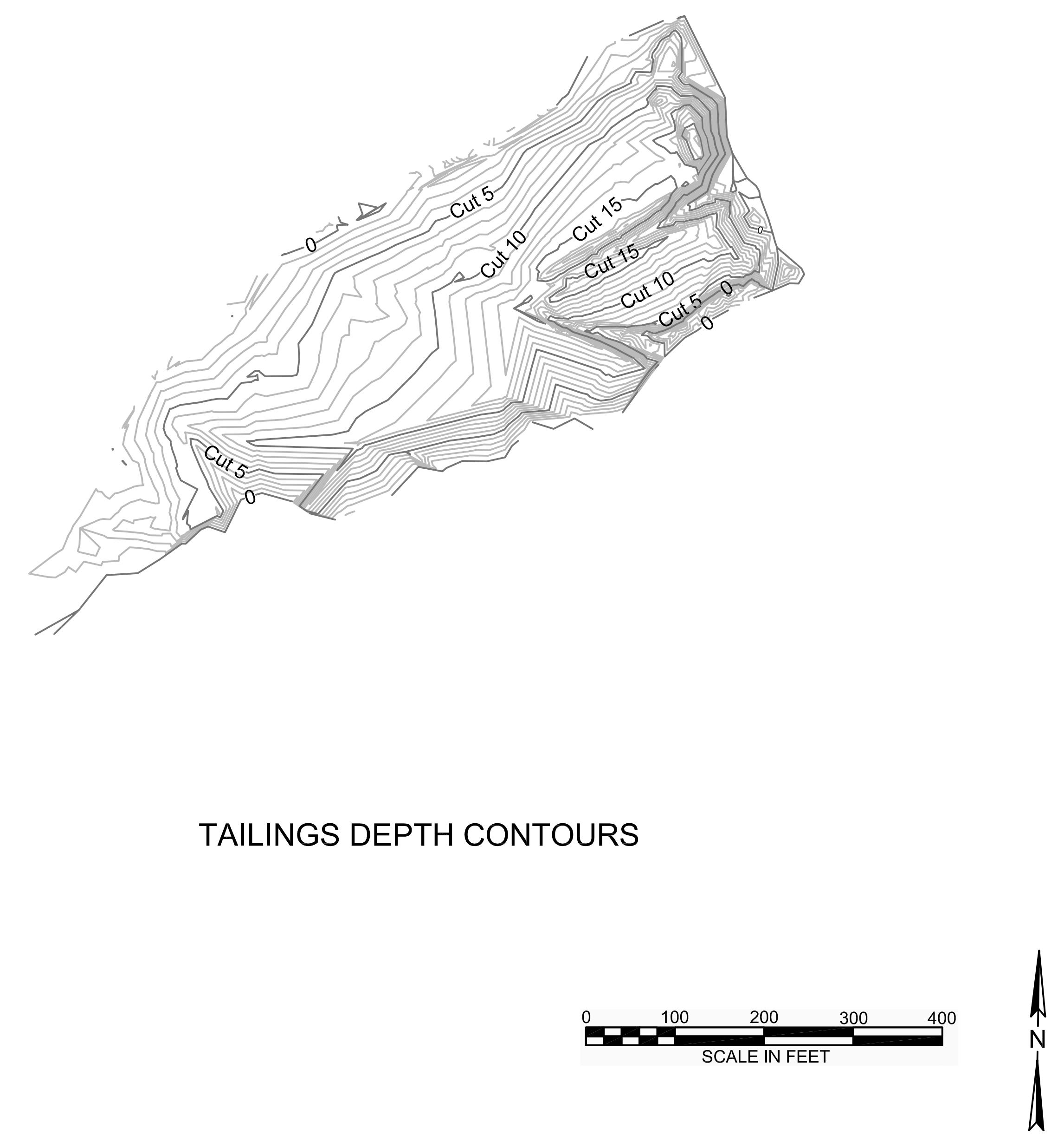
NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: crs	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	DRUMLUMMON TAILINGS AREA	FIGURE 6-1
				APPROVED:	DATE: 8/2002	JOB NO: A1284				
				SCALE: AS SHOWN	FILENAME: A1284Druml.dwg					



PROJECTED NATIVE SURFACE

Prismoidal Volume Results

Original Surface Model:	Drumlummon
Final Surface Model:	Native
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	59777 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	59777 cu yd
Raw Fill Volume:	272 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	272 cu yd



TAILINGS DEPTH CONTOURS

NO.	REVISION DESCRIPTION	BY	DATE

DESIGN: | DRAWN: KSR | CHECKED: CRS
APPROVED: | DATE: 8/2002 | JOB NO: A1284
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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

DRUMLUMMON TAILINGS
PROJECTED NATIVE SURFACE
AND DEPTH CONTOURS

FIGURE
6-2

Table 6-2. Silver Creek Drainage Project Waste Volume Summary

Source	Volume (CY)	Subtotal (CY)	Calculation Method
Drumlummon Mine			
Waste Rock Pile WR1	1460		Eagle Point surface model
Waste Rock Pile WR2	2960		Eagle Point surface model
		4420	
Drumlummon Millsite			
Tailings			
Mill Foundation	50		Visual Estimate
TP-1	4530		Plan area times median depth
TP-2	1540		Plan area times median depth
TP-3	4450		Plan area times average depth
Drumlummon Tailings (DT)	59780		Eagle Point surface model
		70350	
Waste Rock			
WR3	3500		Eagle Point surface model
WR4	110510		Eagle Point surface model
		114010	
Goldsil			
Main Tailings (GT)	458430		Eagle Point surface model
Lined Pond Area Tailings	3440		Eagle Point surface model inside pond berm
Lined Pond Berm Tailings	7550		Pond berm (Top 5 feet mixed native/tailings) from Eagle Point surface model
		469420	
Millsite Area (GM)			
Block #			
1 - Lined Ditch	660		Plan area times median depth
2 - Lobe North of Lined Ditch	740		Plan area times median depth
3 - Mill Vat Tank Area	1200		Eagle Point surface model
4 - Mill Ramp Area	19870		Eagle Point surface model
5 - Mill Tanks	80		Plan area times depth
		22550	
Upper Pond (UP)			
Main	17400		Eagle Point surface model
Northwest Lobe	3320		Eagle Point surface model
		20720	
Middle Pond (MP)	11110	11110	Plan areas times depths
Lower Pond (LP)			
Main	20710		Eagle Point surface model. Includes placer pile islands
Placer Islands	-3040		Subtract Lower Pond placer pile islands
		17670	
	Total Tailings	611820	Cubic Yards
	Total Waste Rock	118430	Cubic Yards
	Total	730250	Cubic Yards

The tailings volume estimate was compared with a historic volume estimate by Consulting Mining Engineer L.S. Ropes that was completed in 1935 (Ropes, 1935). The volume estimate was completed as part of a feasibility study for reprocessing tailings associated with the St. Louis and Drumlummon mines. Tailings were identified and characterized by Ropes in eight separate areas including two tailings dams directly below the Drumlummon mill, the Drumlummon tailings (considered as two separate crib dam areas deposited by the St. Louis and Drumlummon mines), the Goldsil tailings (referred to as the cyanide dump, which was considered as two separate areas), an area referred to as the Duck Pond (descriptions given by Ropes indicate that this is probably the Upper Pond Area) and an area referred to as Dam No. 5, which was noted as having practically disappeared. After reviewing this work, it was evident that Ropes' two crib dams and cyanide dump correspond to the Drumlummon and the Goldsil tailings, respectively. Since these areas represent the majority of the tailings volume identified in the Phase I and Phase II characterization, only these two current volume estimates are compared with the historic work. The Goldsil tailings volume is compared to the historic work in Section 6.1.2.1.

As part of the Ropes study, the Drumlummon tailings were drilled and sampled on a 50 foot by 50 foot grid. Ropes reported the Drumlummon tailings quantity as 57,500 tons. At the reported tailings density of 20 cubic feet per ton, this is equivalent to approximately 42,600 cubic yards. This is less than the nearly 60,000 cubic yards that are currently in the Drumlummon tailings area. However, production records indicate that an additional 57,057 tons of ore were processed at the Drumlummon mill from 1936 through 1948 (McClernan, 1983). This would have resulted in approximately another 42,000 cubic yards of tailings, although it is not known whether these tailings were discharged to the Drumlummon tailings pile or to some other location.

Ropes' drill holes and tailings depth data were digitized and overlaid on the existing Drumlummon tailings depth contours to compare the tailings thickness data. Appendix E contains a map (Figure E1) showing Ropes' drill hole locations relative to the current Drumlummon tailings configuration, and another map (Figure E2) showing a comparison of the existing Drumlummon tailings depth contours to Ropes' tailings depths. In general, the tailings depth data compare well, except the existing depth data show more tailings in the central portion of the pile, which explains why the current tailings volume is greater than the historic volume estimate.

6.1.1.2 Tailings Piles Geology

The Drumlummon tailings pile geology is based on observations made from 21 backhoe test pits (Figure 6-1). The tailings pile is comprised predominantly of light tan to tan silty sand with variable degrees of red to orange brown iron oxide (FeOx) coloration. Lesser amounts of light greenish gray, silty sand tailings are present. The silty sand tailings is generally dry, but some areas may contain slight moisture. Thin bands, streaks and clots of moist silty clay may be present in the silty sand tailings. More clay-rich tailings slime zones are generally characterized by tan to bluish gray silty clay to clayey silt zones. The thicker tailings slime zones are commonly saturated causing very unstable pit walls in the backhoe excavations. The thicker tailings slime zones were intercepted in test pits DT1, DT4, DT10 and DT12. The areal extent of these pits indicate that the slime zone is located in the central portion of the tailings pile (Figure 6-1). The current Silver Creek channel traverses through this area.

The red to orange brown coloration in the Drumlummon tailings pile indicates that iron oxidation (FeOx) is present. Iron oxidation may be the result of oxidized ore mined from the upper portions of the vein system, primary sulfide oxidation in the tailings pile or a combination of both. Of all the tailings piles investigated in the Silver Creek Drainage project, the Drumlummon tailings pile contains the most iron oxide coloration.

The native surface below the tailings was intercepted in all of the test pits except for DT4 and DT10 in which saturated slimes caused major pit wall collapse. The native soils generally consist of light brown sandy gravel with rock up to 12-inch diameter. The rock is generally angular to subrounded, suggesting the native material is probably colluvium verses alluvium. The native sediments generally not did contain significant moisture. Some of this material may be related to placer operations that pre-dated the emplacement of the mill tailings. Iron oxide coloration in the native soils appears to be highly variable but generally minor in concentration with the exception of two pits, DT2 and DT12, where native sediments contain abundant orange brown FeOx.

Drumlummon tailings particle size analyses were conducted on samples collected from backhoe test pit DT10. The laboratory results are contained in Appendix C and the data are presented in Table 6-3. Laboratory analysis indicates that the predominant tailings texture is characterized as a sandy loam whereas the lesser slime-rich tailings are characterized as a silty loam containing 10 percent clay.

6.1.1.3 Tailings Piles Metal/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from the test pit wall or from grab samples collected from the test pit excavation stockpile. Individual samples were collected based on similar geologic characteristics. Twenty two tailings samples and four representative composite tailings samples were collected from the Drumlummon tailings pile for XRF screening. In addition, five native soil samples were collected from below the tailings near the contact zone for XRF screening. The XRF results are contained in Appendix B. The XRF results indicate that the principal elements of concern, i.e. As, Cd, Cu, Pb, Hg and Zn are either below analytical method detection limit or in low concentration. Laboratory analytical data for the four composite samples are summarized in Table 6-1. The tailings pH is alkaline ranging from 7.7 to 7.9 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: Ag - 16.4 mg/Kg (6.6x), As - 11.7 mg/Kg (0.6x), Ba - 47.4 mg/Kg (0.3x), Cr - 7.1 mg/Kg (0.6x), Cu - 62.4 mg/Kg (1.8x), Fe - 7,684.0 mg/Kg (0.6x), Pb - 54.4 mg/Kg (4.8x), Mn - 438.2 mg/Kg (0.9x), Sb - 5.0 mg/Kg (1.0x) and Zn - 102.6 mg/Kg (1.5x). The following parameters were not detected or had more than 50 percent of the concentrations at or below the method detection limit: Cd, Hg, Ni, and total cyanide. The laboratory quantitative analyses on representative composite samples corroborate the XRF screening results. The chemistry results indicate that the Drumlummon tailings contain low concentrations for the elements of concern. Silver and Pb were the only analyte with an average concentration greater than three times the average background soil concentration.

Native soil samples were collected below the tailings pile from backhoe test pits DT2, DT3, DT8, DT12 and DT13. The five samples were analyzed via XRF and the results are contained in Appendix B. The results for the potential contaminants are below detection limit or are in low concentrations indicating that the native soils do not appear to be impacted by the mill tailings.

Table 6-3. Mill Tailings Particle Size Results

	Weight Percent Retained					Percent Finer by Weight								
Sample ID	Gravel	Sand			Silt/Clay	Gravel	Sand			Silt/Clay				
Sieve Size	3/4-in	#4	#10	#40	#200	3/4-in	#4	#10	#40	#200	Percent	Percent	Percent	Soil
Opening (Inches)	0.75	0.187	0.0661	0.0106	0.0029	0.75	0.187	0.0661	0.0106	0.0029	Sand	Silt	Clay	Texture
GT19 0-2.3	<0.1	0.1	0.1	3.7	74.7	100	99.9	99.8	96.1	21.4	76	18	6	Sandy Loam
GTDH9 15-20	2.2	2.6	2.6	7	65.9	97.8	95.2	92.6	85.6	19.7	72	22	6	Sandy Loam
GTDH2 20-25	0.1	<0.1	0.1	1	71.8	99.9	99.9	99.8	98.8	27	62	32	6	Sandy Loam
GTDH2 0-5	<0.1	<0.1	<0.1	0.1	30.8	100	100	100	99.9	69.1	28	56	16	Silty Loam
DT10 0-3.7	<0.1	<0.1	<0.1	0.2	71.3	100	100	100	99.8	28.5	65	29	6	Sandy Loam
DT10 3.7-10	<0.1	<0.1	<0.1	<0.1	3.3	100	100	100	100	96.7	14	76	10	Silty Loam
GM12 0-10	<0.1	0.1	0.4	3.4	52.2	100	99.9	99.5	96.1	43.9	44	42	14	Loam
GM26 0-3.8	5.3	3.2	3.2	9.7	35	94.7	91.5	88.3	78.6	43.6	38	48	14	Loam

LEGEND

GT - Goldsil Tailings backhoe test pit sample
GTDH - Goldsil Tailings geoprobe drill hole sample
GM - Goldsil Mill Tailings backhoe test pit sample
DT - Drumlummon Tailings backhoe test pit sample

6.1.2 Goldsil Tailings

The Goldsil tailings piles are located in the SE¼ Section 33 and SW¼ Section 34, Township 12 North and Range 5 West, Montana Principal Meridian (Figure 1-1). The Goldsil tailings contain the highest volume of mill tailings identified in the Silver Creek Drainage project. The area encompassing the Goldsil mill tailings extends from just north of the Argo millsite to the Goldsil millsite, a distance of approximately 4,000 feet. An overview of the Goldsil millsite and tailings area is presented in Figure 6-3. Additional larger scale maps showing the details of the Goldsil tailings area are presented in Figures 6-4, 6-5, 6-6, and 6-7.

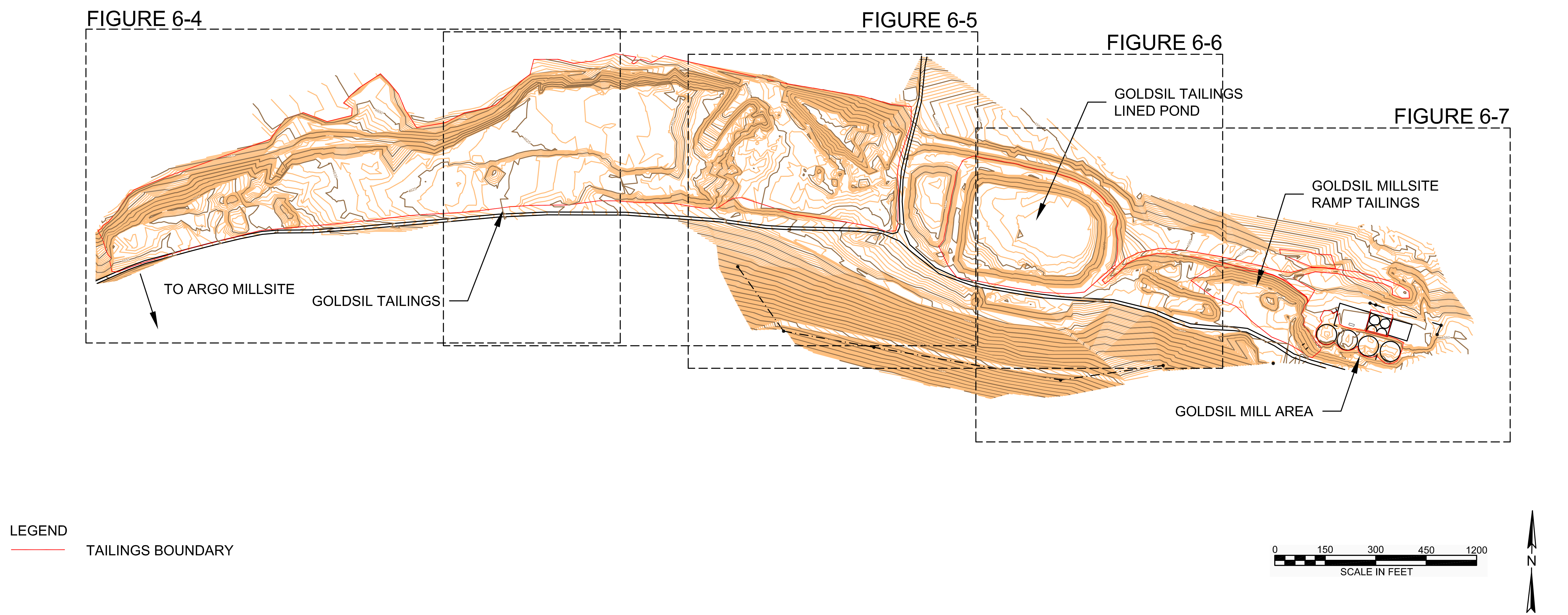
The tailings are generally moderately to well vegetated with grasses, shrubs and trees. The Goldsil tailings are complex because some zones have been disturbed due to 1) secondary mining and reprocessing and, 2) sediment erosion caused by storm water and snowmelt runoff. An open pit mine was presumably constructed in the 1970’s near the central portion of the Goldsil tailings area (Figure 6-5) to extract and reprocess tailings for gold and silver. Based on the size of the open pit mine area and various interpretations of the pre-mining topographic surface, it is estimated that from 108,000 to 178,000 cubic yards of tailings were removed from the pile during this operation. It is not known whether all or only a portion of the extracted tailings were reprocessed at the Goldsil millsite. This millsite was originally constructed by John White in the early 1970’s and then sold to Goldsil Ranchers Company in the late 1970’s.

The composition of the tailings in the western end of the Goldsil tailings pile also suggests that tailings in this area may have been subjected to secondary processing. The tailings contain a mixture of fine tailings sediment, gravel and some rock. These tailings may have been drag-lined out of the Silver Creek drainage for reprocessing, possibly during the Argo Mill era when tailings were reprocessed by cyanide vat leaching method.

6.1.2.1 Tailings Pile Volume Estimate

The Goldsil tailings volume was estimated using the detailed topographic survey of the tailings surface and the drill hole and test pit data. The drill hole and test pit data were used to evaluate the depth of the tailings and the elevation of the native surface below the tailings. Because of the size and complexity of the Goldsil tailings area, it was divided into subareas which were evaluated separately. The volumes of larger subareas were calculated using the Eagle Point prismoidal method as described in Section 6.1.1. Volumes in smaller subareas were calculated from plan area and tailings depth data. Volumes were calculated for the following Goldsil tailings subareas:

- the main Goldsil tailings is located west of the upper Goldsil access road;
- tailings within the lined pond east of the Goldsil tailings;
- the lined pond berm which appears to be a mixture of tailings and native soil;
- the lined ditch from the lined pond that flows to a former pond north of the Goldsil mill area;
- a lobe of tailings located north of the lined ditch;
- the Goldsil mill vat tank area;



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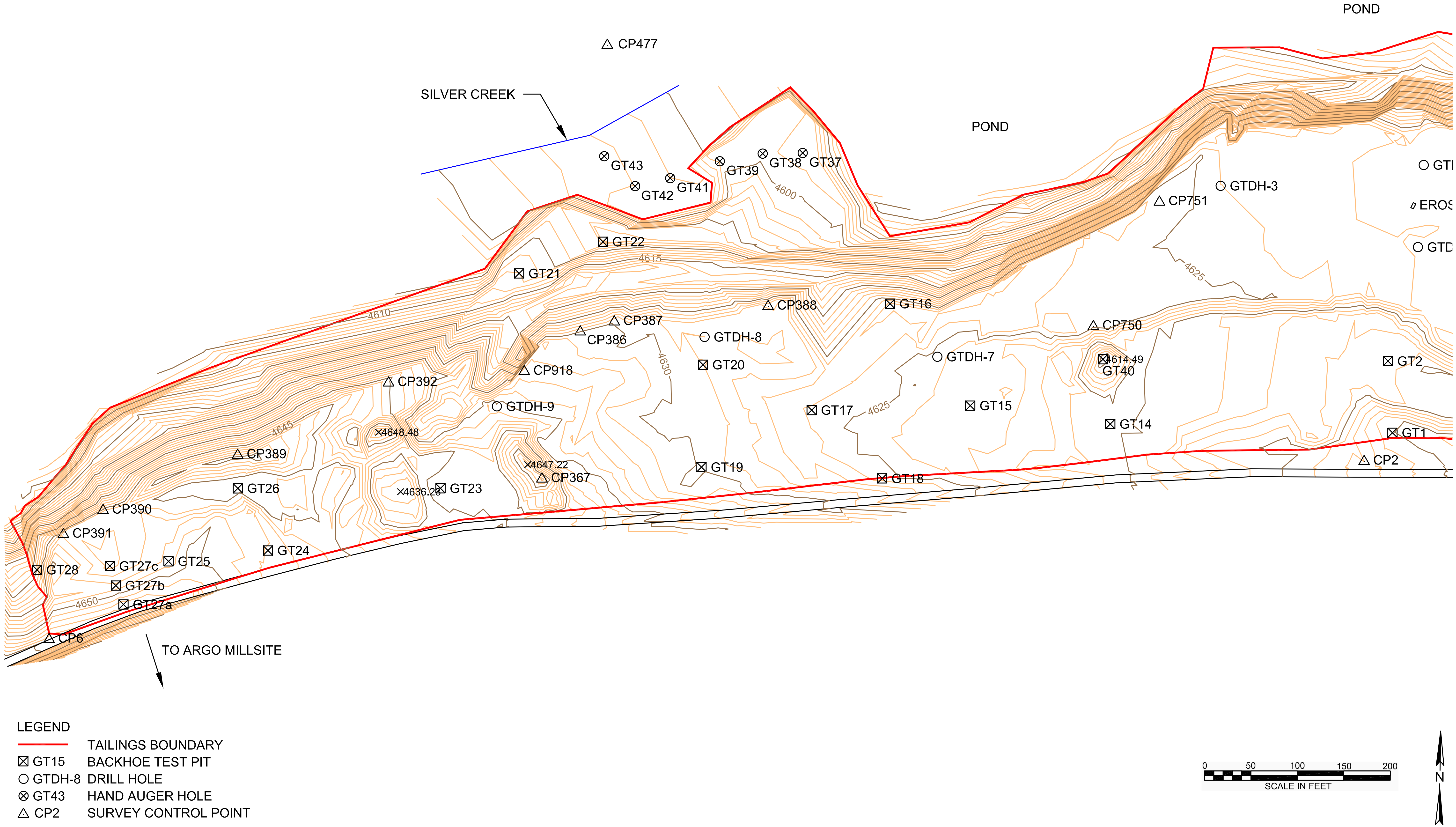

LEGEND

	TAILINGS BOUNDARY
⊠ GT15	BACKHOE TEST PIT
○ GTDH-8	DRILL HOLE
⊗ GT43	HAND AUGER HOLE
△ CP2	SURVEY CONTROL POINT

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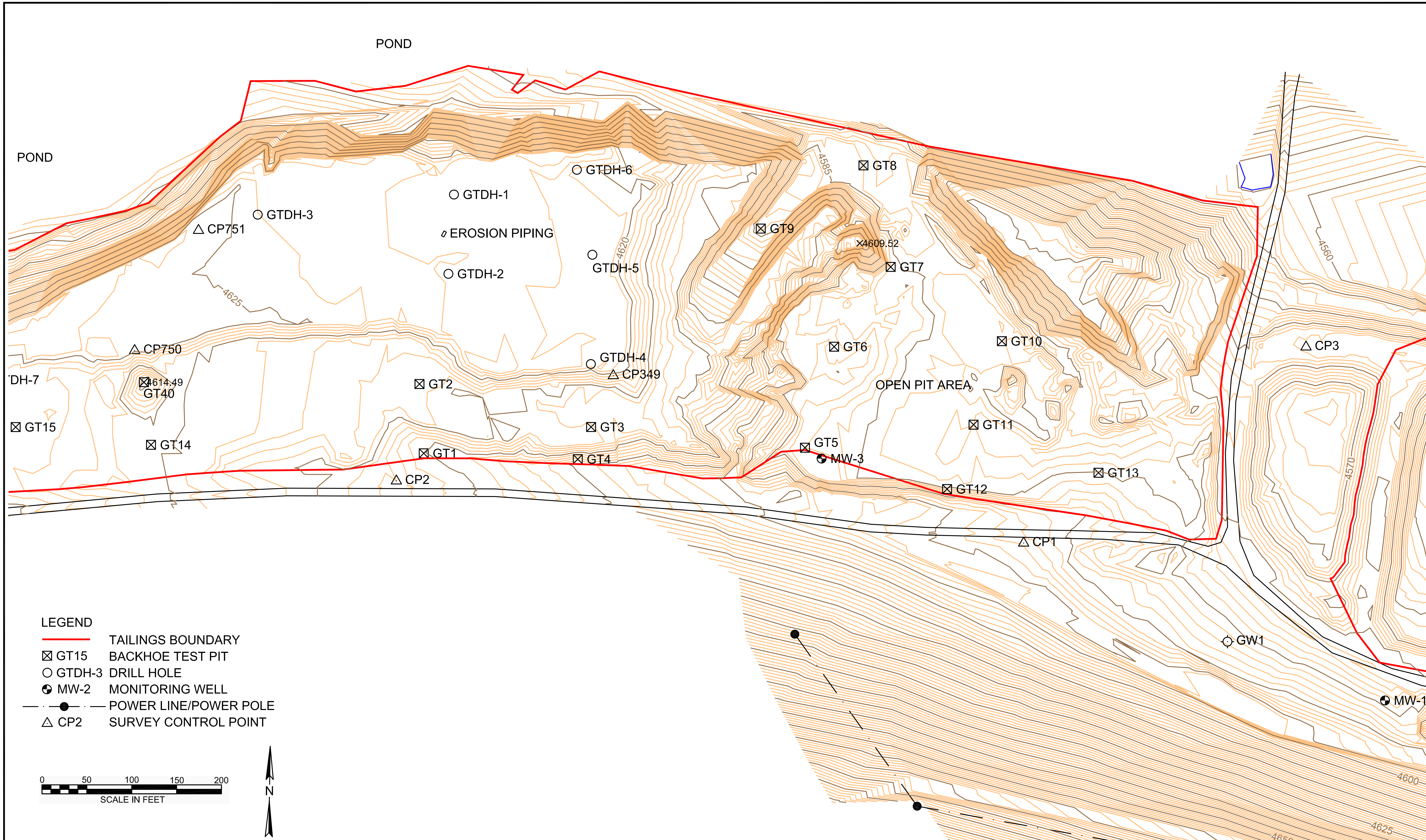
MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

WEST END OF GOLDSIL TAILINGS

FIGURE 6-4



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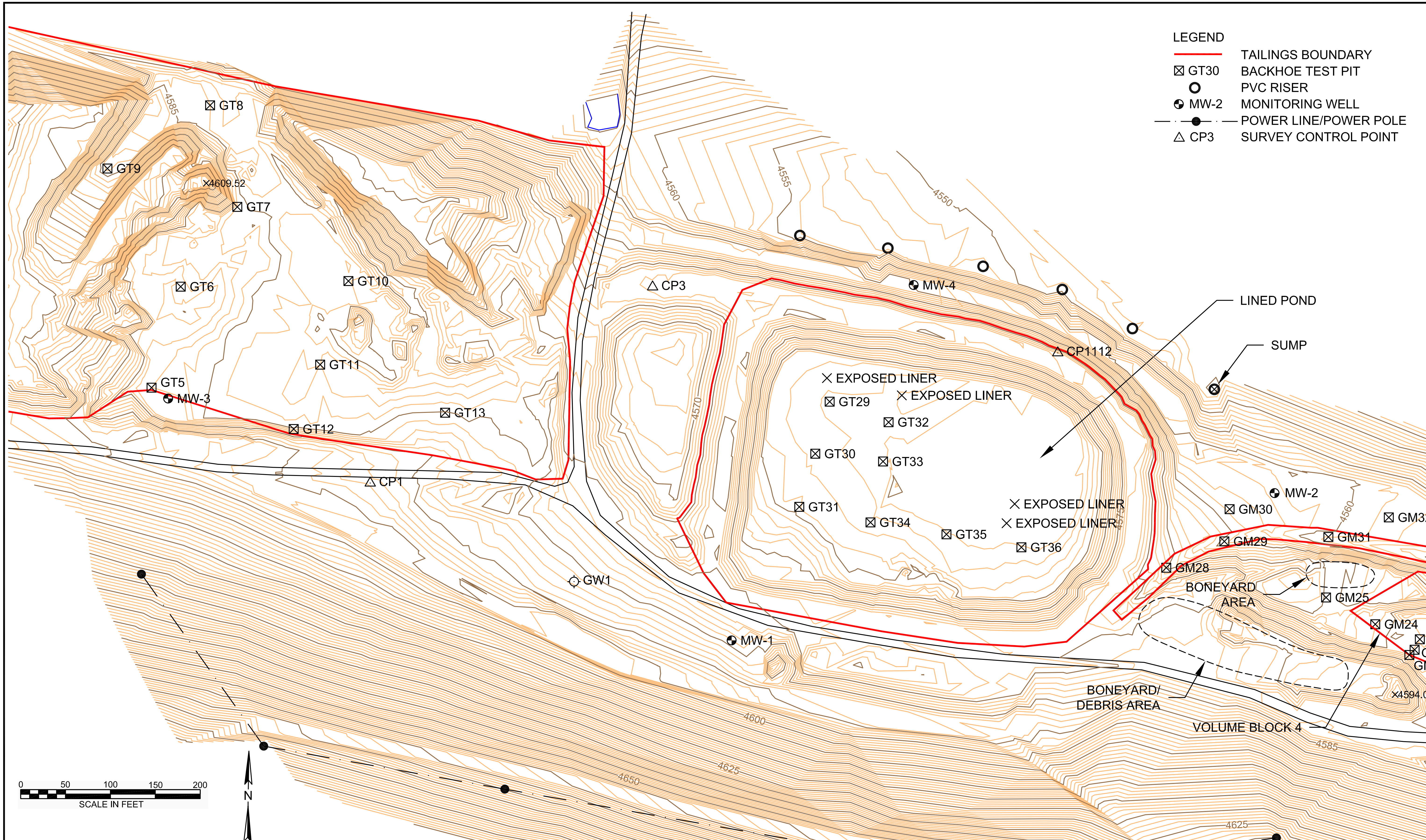
				APPROVED:	DATE: 8/2002	JOB NO: A1284				
				SCALE: AS SHOWN	FILENAME: A1284GM.dwg					



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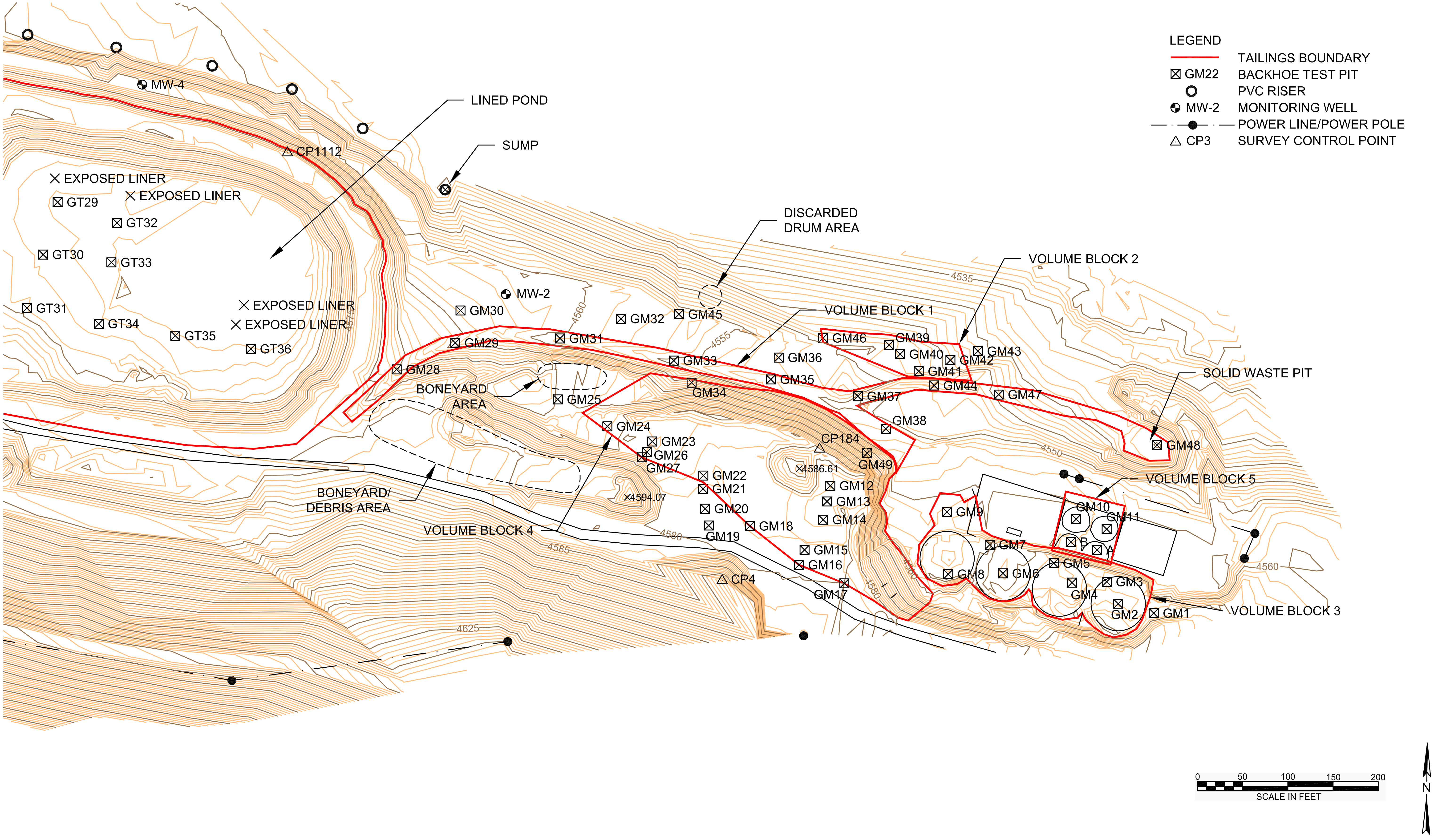
MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL MILLSITE
LINED TAILINGS IMPOUNDMENT

FIGURE
6-6



NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	GOLDSIL MILLSITE AREA	FIGURE 6-7
				APPROVED:	DATE: 8/2002	JOB NO: A1284				
				SCALE: AS SHOWN	FILENAME: A1284GM.dwg					

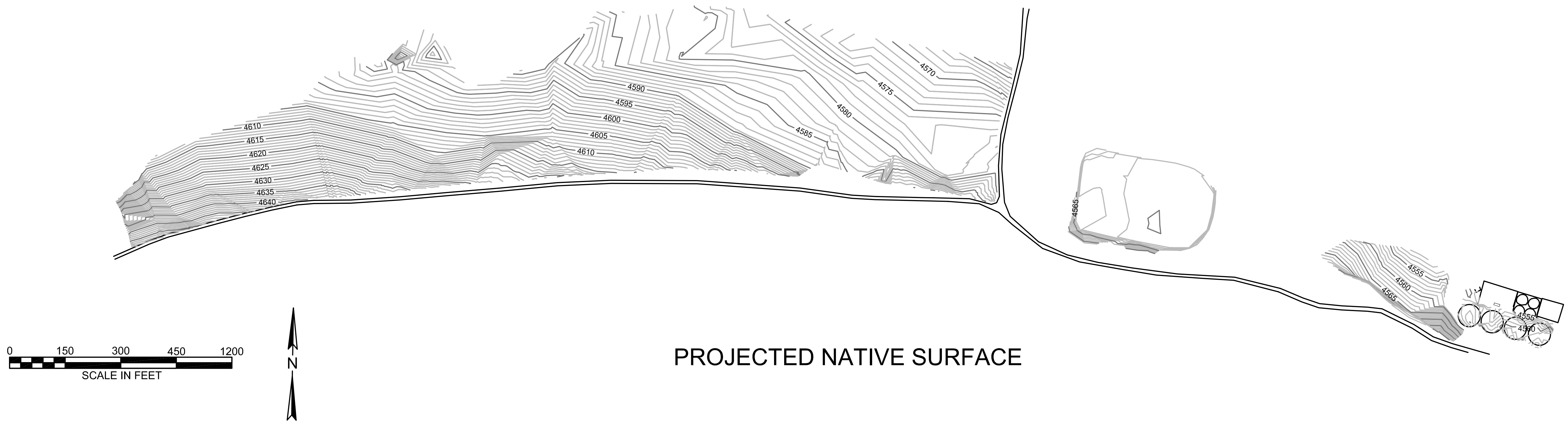
- the ramp west of the Goldsil mill; and
- the tanks within the Goldsil mill foundation.

The volume of the main Goldsil tailings was calculated using Eagle Point surface models. The existing tailings surface model was compiled from the topographic survey. The native surface (Figure 6-8) was triangulated from native surface elevations encountered in the test pits and drill holes. A total of 35 test pits were excavated and nine holes were drilled into the main Goldsil tailings (Figures 6-4 and 6-5). The estimated volume of the main Goldsil tailings is 458,430 cubic yards (Table 6-2). The tailings plan area is 18.68 acres and the average tailings depth is 15.21 feet. The maximum tailings thickness measured in the drill holes was 42.65 feet.

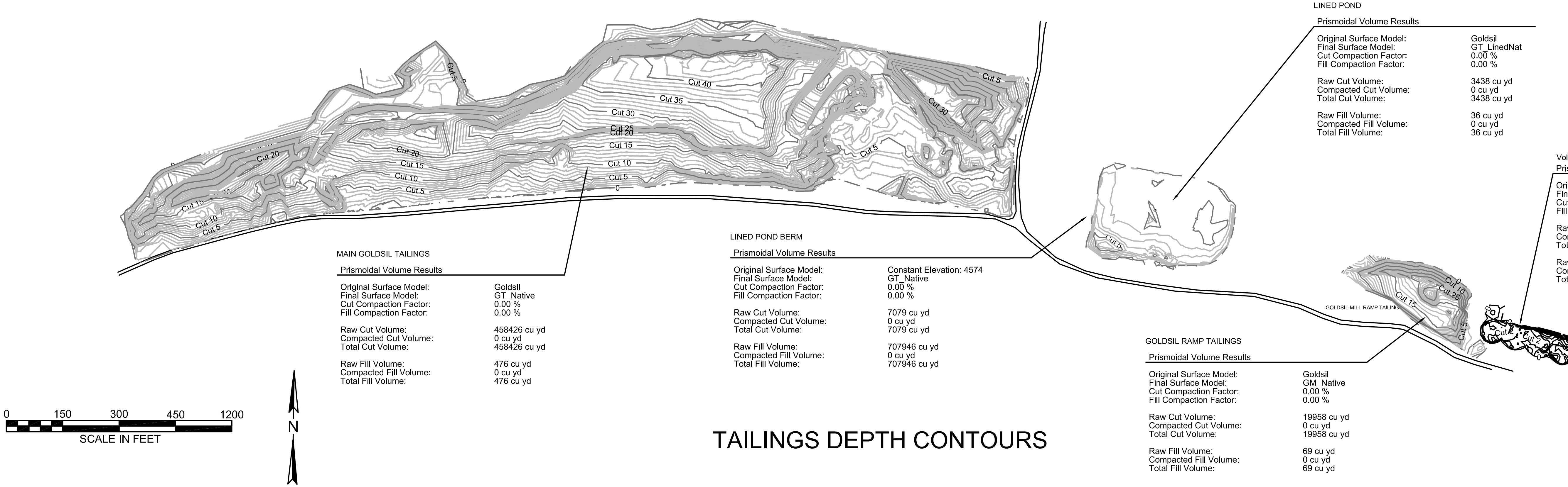
The main Goldsil tailings volume was compared with a historic volume estimate by Consulting Mining Engineer L.S. Ropes that was completed in 1935 (Ropes, 1935). The volume estimate was completed as part of a feasibility study for reprocessing tailings associated with the St. Louis and Drumlummon mines. The Goldsil tailings were referred to by Ropes as the "cyanide dump". As part of the early feasibility study, the cyanide dump was drilled and sampled on a 100 foot by 100 foot grid. Ropes reported the cyanide dump tailings quantity as 781,500 tons. At the reported tailings density of 20 cubic feet per ton, this is equivalent to approximately 578,900 cubic yards. This is more than the 458,430 cubic yards estimated by Olympus. However, Ropes' estimate was completed before tailings were removed from the open pit area at the west end of the Goldsil tailings. Olympus estimated the volume of tailings removed from the open pit area was between 108,000 and 178,000 cubic yards. Adding that to the current estimate gives a volume range of 566,430 to 636,430 cubic yards, which compares well with Ropes 1935 volume estimate. As discussed in Section 6.1.1.1, production records indicate that an additional 57,057 tons of ore were processed at the Drumlummon mill from 1936 through 1948 (McClernan, 1983). This would have resulted in approximately another 42,000 cubic yards of tailings, although it is not known to which tailings pile they would have been discharged.

Ropes' drill holes and tailings depth data were digitized and overlaid on the existing Goldsil tailings depth contours to compare the tailings thickness data. Appendix E contains a map (Figure E3) showing Ropes' drill hole locations relative to the current Goldsil tailings configuration, and other maps (Figures E4 and E5) showing comparisons of the existing Goldsil tailings depth contours to Ropes' tailings depths. In general, the tailings depth data compare well, with the exception of the open pit area at the east end of the Goldsil tailings, where tailings have been removed.

The volume of tailings within the lined pond (Figure 6-6) east of the main Goldsil tailings was calculated using Eagle Point surface models. The existing tailings surface was compiled from the topographic survey. The surface at the bottom of the lined pond was triangulated from test pit elevation data and from surveying the locations of exposed liner (i.e., zero tailings). A total of eight test pits were excavated in the lined pond area. Exposed liner was observed in four locations. The estimated volume of tailings in the lined pond is 3,440 cubic yards. The plan area of the lined pond is 1.97 acres and the average tailings depth is 1.08 feet. The maximum tailings depth observed in the test pits is 1.8 feet in the southwest corner. Based on the topography, this area appears to be a beach deposit near the tailings discharge point.



PROJECTED NATIVE SURFACE



MAIN GOLDSIL TAILINGS

Prismoidal Volume Results

Original Surface Model:	Goldsil
Final Surface Model:	GT_Native
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	458426 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	458426 cu yd
Raw Fill Volume:	476 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	476 cu yd

LINED POND BERM

Prismoidal Volume Results

Original Surface Model:	Constant Elevation: 4574
Final Surface Model:	GT_Native
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	7079 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	7079 cu yd
Raw Fill Volume:	707946 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	707946 cu yd

LINED POND

Prismoidal Volume Results

Original Surface Model:	Goldsil
Final Surface Model:	GT_LinedNat
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	3438 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	3438 cu yd
Raw Fill Volume:	36 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	36 cu yd

Volume Block 3 (Mill Vat Tank Area)

Prismoidal Volume Results

Original Surface Model:	Goldsil
Final Surface Model:	Mill_native
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	1189 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	1189 cu yd
Raw Fill Volume:	19 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	19 cu yd

GOLDSIL RAMP TAILINGS

Prismoidal Volume Results

Original Surface Model:	Goldsil
Final Surface Model:	GM_Native
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	19958 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	19958 cu yd
Raw Fill Volume:	69 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	69 cu yd

TAILINGS DEPTH CONTOURS

				DESIGN:	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	GOLDSIL TAILINGS PROJECTED NATIVE SURFACE AND DEPTH CONTOURS	FIGURE 6-8
				APPROVED:	DATE: 8/2002	JOB NO: A1284				
NO.	REVISION DESCRIPTION	BY	DATE	SCALE: AS SHOWN	FILENAME: A1284GM.dwg					

The berm that forms the lined pond appears to be a mixture of tailings and native soil. Based on visual observation, the upper five feet of the pond berm appear to be impacted by tailings. Based on the topographic survey, the top of the pond berm is at an elevation of approximately 4,579 feet. With an impacted berm depth of 5 feet, the elevation of the bottom of the impacted berm is 4,574. The impacted berm volume was calculated using Eagle Point surface models. The top surface was compiled from the topographic survey. The bottom surface was taken at a constant elevation of 4,574. The estimated volume of impacted tailings berm is 7,550 cubic yards. The plan area of the impacted berm is 1.87 acres and the average tailings depth is 2.50 feet.

The volume of tailings in the lined ditch from the southeast corner of the lined pond that flows to a former pond north of the Goldsil mill area (Figure 6-7, Volume Block 1) was estimated from the plan area times the median tailings depth. A total of 10 test pits were excavated in the lined ditch area. The tailings depth ranged from 0.2 to 3.4 feet, with a median depth of 1.0 feet. The plan area of the lined ditch is 0.41 acres and the estimated tailings volume is 660 cubic yards.

The volume of the lobe of tailings located north of the lined ditch (Figure 6-7, Volume Block 2) was estimated from the plan area times the median tailings depth. A total of five test pits were excavated in the tailings lobe. The tailings depth ranged from 3.0 to 6.0 feet with a median depth of 3.8 feet. The plan area of the tailings lobe is 0.12 acres and the estimated tailings volume is 740 cubic yards.

The volume of tailings within the former vat tank area at the Goldsil millsite (Figure 6-7, Volume Block 3) was calculated using Eagle Point surface models. The existing tailings surface was compiled from the topographic survey. The surface at the bottom vat tanks triangulated from test pit elevation data. A total of eight test pits were excavated in the vat tank area. The estimated volume of tailings in the vat tank area is 1,200 cubic yards. The tailings plan area is 0.43 acres and the average tailings depth is 1.73 feet. The maximum tailings depth observed in the test pits was 4.4 feet.

The volume of the Goldsil millsite ramp area tailings (Figure 6-7, Volume Block 4) was calculated using Eagle Point surface models. The existing tailings surface model was compiled from the topographic survey. The native surface was triangulated from native surface elevations encountered in the test pits. A total of 18 test pits were excavated into the ramp area tailings. The estimated volume of the Goldsil millsite ramp area tailings is 19,870 cubic yards. The tailings plan area is 1.07 acres and the average tailings depth is 11.55 feet. The maximum tailings thickness observed in the test pits was 13.8 feet.

The volume of tailings in the tank bottoms within the Goldsil mill foundation (Figure 6-7, Block 5) was calculated based on the depth of tailings and the plan area of the tanks. Two 30-foot diameter tanks, with 1.4 and 0.8 feet of tailings, respectively, and two 30-foot diameter half tanks, with 0.7 and 0.8 feet of tailings were present within the mill foundation. The estimated volume of tailings in the mill tanks is 80 cubic yards.

6.1.2.2 Tailings Piles Geology

The Goldsil tailings incorporate a number of areas as described above. Test pits and drill holes were used to evaluate the tailings contained in the Goldsil mill area (test pits GM -1 through GM-11), the Goldsil ramp area (test pits GM-12 through GM-25; GM-49), the Goldsil lined tailings pond (test pits GT-29 through GT-36), the Goldsil drainage ditch and terrace immediately to the north (test pits GM-28 through GM-48) and the main Goldsil tailings pile (test pits GT-1 through GT-28; GT-37 through GT-40; and drill holes GTDH-1 through GTDH- 9). The following field observations are summarized from the test pit and drill hole observations.

The tailings contained in the Goldsil mill area are generally grayish white to light tan, silty sand containing minor red brown to orange brown FeOx especially near the subsurface, rusted, steel tank bottom. Some minor steel piping was observed in the test pits constructed along the berm between the mill foundation and the former vat leach tank area. The native surface which is probably composed of fill in the mill area consists of dark brown sandy loam containing gravel and rock debris generally ≤ 6-inch diameter. Minor metal debris was observed in some of the subgrade fill materials. The western-most former vat leach tank area (test pit GM-8) contains a small patch of willows and the tailings were moist down to a depth of 4.4 feet at which the metal tank bottom was intersected. The white to light gray, silty sand tailings associated with the former vat areas within the main mill foundation are generally thin at ≤ 1.4 feet maximum thickness.

The ramp area portion of the Goldsil tailings is located immediately to the west of the Goldsil millsite. The concrete retaining wall marks the eastern edge of the ramp tailings area. Backhoe test pits GM-12 through GM-14 were in the thicker portion of the ramp tailings area and did not intersect the native surface below the tailings. Pit depths ranged from 10 feet to 13.5 feet. Test pits GM-15, GM-18 and GM-22 intersected vertical, wooden crib walls that most likely were constructed as a tailings retaining wall when the tailings impoundment was built. Test pits indicate that the crib walls form the contact between tailings and native materials. Some steel cable, iron debris and 2-wire electric cable are associated with the wooden crib walls. The tailings are generally grayish white to light tan, silty sand and may contain some clayey silt near the lower contact with native materials. The native soils are generally composed of a dark brown, sandy loam with some gravel and variable amounts of rock debris generally ≤ 10-inch diameter. The native soils in contact with tailings did not contain any significant concentration of FeOx.

The tailings contained in the lined tailings pond, within the lined ditch running from the tailings pond to the Goldsil millsite area and on the terrace immediately to the north of the drainage ditch are generally light tan, silty sands. In the lined tailings pond, two areas representing discharge points are generally thicker and coarser grained in that they contain more sand than the silty sand tailings located to the north of the discharge points. The integrity of the PVC liners containing tailings in both the pond and drainage ditch areas is poor. Numerous puncture holes or tears were evident prior to any test pit construction. In both cases, it appears that the PVC liners were placed upon a heterogenous mixture of sand and gravel with generally abundant angular to subrounded rock ≤ 12-inch diameter.

The eastern end of the main Goldsil tailings pile is located to the west of the lined tailings pond. The main Goldsil tailings are composed predominantly of light tan to tan, fine-grained, silty sand. The finer grained tailings may show floury texture which when disturbed tends to be a source of dust. Lesser lenses or thin layers of tan clayey silt are generally slightly moist and when excavated appear as blocky chunks in the silty sand. The tailings range from massive to well layered where layers are usually thin and near horizontal in orientation. The native soils below the tailings are generally characterized as dark brown sandy loam with abundant subangular to angular rock generally ≤ 12-inch diameter. These materials are probably colluvium generated from the steep slopes located to the south of the tailings area. In some areas, the tailings appear to be deposited on placer tailings consisting of sand, gravel and rounded rock debris generally ≤ 12-inch diameter. The native materials below the tailings generally do not show any FeOx except for minor occurrences where yellow brown FeOx may be present.

Black charcoal chunks generally ≤ 2-inches in diameter are conspicuously present in some areas of the Goldsil tailings. They can be observed in the vertical walls of the open pit mine area and in many of the test pits excavated in the eastern half of the tailings pile. The almost disseminated nature of the charcoal suggests that it may have been deposited along with the tailings slurry and not be related to a forest fire event. The source of the charcoal may well be the wood used as an energy source in the early mill operations, i.e. boilers. Similar charcoal materials were noted in the exposed cut faces of the large waste rock pile located immediately to the west of the Drumlummon mill foundation. The west end of the Goldsil tailings pile is commonly composed of silty sand tailings along with gravel and some rock. The amount of gravel and rock associated with the tailings in this area is unusual in that it is not just surficial, suggesting that the tailings may have been disturbed for secondary processing. Historical references (Olympus, 2002) indicate that the Argo mill was operated exclusively for reprocessing of tailings presumably generated from the Drumlummon tailings. The amount of gravel and rock in the tailings suggest that they may have been excavated from their original deposition site using some sort of drag-line type operation.

In general, most of the Goldsil tailings are dry with the exception of test pits and/or hand auger drill holes located near the extreme northern boundary of the tailings pile, i.e. in the area of test pits (GT-21 and GT-22) and auger holes (GT-37, GT-38, GT-39, GT-41 and GT-42). Six samples of Goldsil tailings were collected from test pits and geoprobe drill cores for particle size analysis. The samples were selected to provide for a representative areal distribution and to characterize the mill tailings at different depths. The laboratory results are contained in Appendix C and the data are presented in Table 6-3. The analytical results indicate that the Goldsil tailings are composed predominantly of silty sand with lesser sandy silt. The soil textures are characterized as sandy loam, silty loam and loam.

6.1.2.3 Tailings Piles Metal/pH Chemistry Results

Representative samples were collected from Geoprobe drill cores, vertical channel samples taken from test pit walls or from grab samples collected from test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. One hundred seventeen tailings samples and seventeen representative composite tailings samples were collected from the Goldsil tailings area for XRF screening. In addition, fourteen native soil samples and three composite native soils were collected for XRF screening. The XRF results are contained in Appendix B. To allow some comparison of the main Goldsil tailings area (GT samples) and the Goldsil mill and ramp tailings area (GM samples), the XRF data results were evaluated separately. The Goldsil tailings (GT) XRF mean concentration results for the principal elements of interest are as follows: Ag (151.4 ppm), As (36.2 ppm), Cd (no detection), Cu (135.5 ppm), Fe (5,661.6 ppm), Hg (81.1 ppm), Pb (185.6 ppm), Mn (553.2 ppm), and Zn (254.3 ppm). The Goldsil mill and ramp tailings area (GM) XRF mean concentration results for the same element suite of interest are as follows: Ag (no detection), As (31.4 ppm), Cd (no detection), Cu (67.0 ppm), Fe (5,998.0 ppm), Hg (57.2 ppm), Pb (146.9 ppm), Mn (283.3 ppm), and Zn (272.6 ppm). The XRF results are generally commensurate with the exception of Ag, Cu, and Mn which are significantly higher concentration in the Goldsil tailings area verses the Goldsil mill and ramp area.

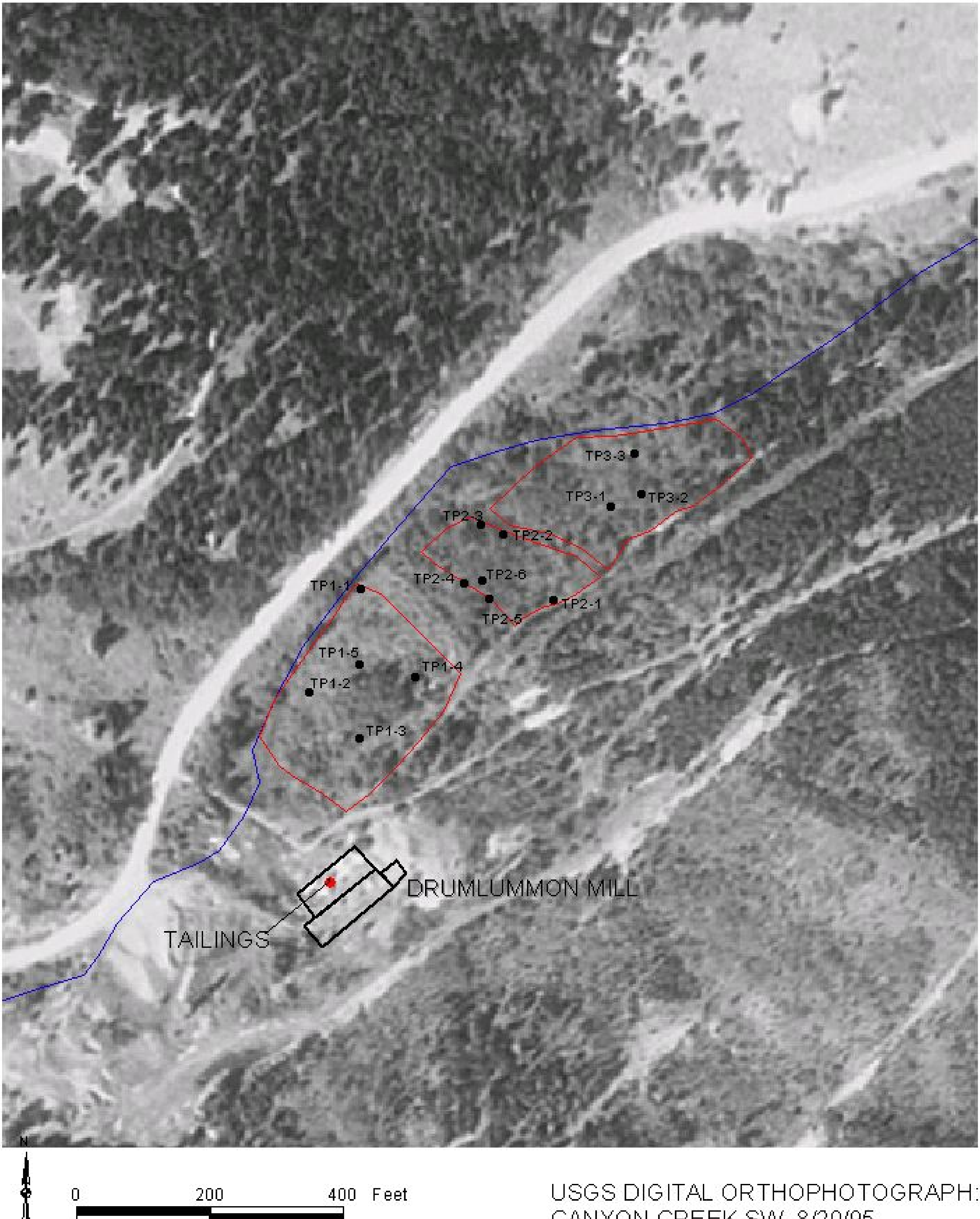
Laboratory analytical data for the seventeen composite samples and two duplicate samples collected from the entire Goldsil tailings area (GT and GM) are summarized in Table 6-1. The laboratory data and chain-of-custody are contained in Appendix C. The tailings pH is alkaline ranging from 7.6 to 8.1 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: Ag - 19.3 mg/Kg (7.7x), As - 31.8 mg/Kg (1.5x), Ba - 48.4 mg/Kg (0.3x), Cd - 3.1 (6.2x), Cu - 171.2 mg/Kg (5.0x), Fe - 6,606.7 mg/Kg (0.5x), Hg - 50.7 mg/Kg (>101.4x), Pb - 181.8 mg/Kg (16.1x), Mn - 699.4 mg/Kg (1.4x), Sb - 15.0 mg/Kg (3.1x), Zn - 354.3 mg/Kg (5.2x) and total cyanide 3.5 mg/Kg. The following parameters were not detected or had more than 50 percent of the concentrations at or below the method detection limit: Cr and Ni. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd which was not detected via XRF. For most parameters, the laboratory quantitative mean concentrations are higher than the XRF mean results except for Ag and Hg. Although the XRF method is not generally very efficient for Hg analysis, the XRF mean concentration results provide a reasonable estimate of the Goldsil tailings laboratory data mean concentration.

The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, Cd, Cu, Hg, Pb, Sb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 3.5 mg/Kg and a maximum concentration of 21 mg/Kg is elevated.

The native soil samples associated with the Goldsil tailings were analyzed for paste pH, As, Cd, Cu, Pb, Hg, Zn and total cyanide. The data indicate that concentrations are generally in the range of background soil concentrations with the exception of Hg and total cyanide. Although the Hg concentrations (2 to 6 mg/Kg) detected in the native soils beneath the tailings are significantly lower than the average concentration of 50.7 mg/Kg in the tailings, they are elevated. It is possible that some of the “native soils” may be placer tailings for it can be difficult differentiating placer tailings from colluvium or alluvium. Total cyanide ranges from no detection to 7.9 mg/Kg in the native soils and the detections indicate that some cyanide appears to be mobilizing into the top of the native soils. A single detection of Cd consistent with the tailings concentration was reported in the composite sample collected from native soils in test pits GT-1 and GT-4.

6.1.3 Drumlummon Millsite Tailings Piles

The Drumlummon millsite tailings piles (TP1, TP2 and TP3) are located in the SE¼ Section 36, Township 12 North and Range 6 West, Montana Principal Meridian (Figure 1-1). The aerial photograph presented in Figure 6-9 shows the location of the tailings piles and test pits used to evaluate the Drumlummon millsite tailings. The tailings piles are located within 900 feet downstream along the Silver Creek drainage from the Drumlummon mill foundation. A berm diverts Silver Creek to the north of the three tailings piles along Marysville Road. Tailings pile TP1, which is the farthest upstream, is formed by a dam across the drainage bottom. The dam has a 10-inch steel pipe through it to provide overflow drainage. The dam is approximately 15 feet high on the downstream side, and there is approximately 8 feet of freeboard on the upstream side. The tailings in the pond are well vegetated with grass and willows.



Legend
- Test Pit
- Tailings Boundary
- Silver Creek

Olympus Technical Services, Inc.

Figure 6-9. Drumlummon Millsite Tailings Piles TP-1, TP-2 and TP-3

Tailings pile TP-2 is located immediately downstream from TP-1. Silver Creek flows to the north and is separated from TP-2 by a berm. Similar to TP-1, the pond is formed by a dam constructed across the drainage bottom. TP-2 is mostly covered with trees, brush and grasses, but has occasional bare spots where tailings are visible. The TP-2 dam is approximately 6 to 8 feet high.

Located immediately downstream of TP-2 is tailings pile TP-3. Silver Creek is still diverted to the north of TP-3. The creek returns to the bottom of the drainage below TP-3. The tailings pile is somewhat irregular in shape, formed by several small berms and was apparently deposited over placer tailings piles. Because of deposition over placer tailings, it has an irregular thickness. The tailings are covered with trees and brush, similar to TP-2.

6.1.3.1 Tailings Pile Volume Estimate

The tailings pile volumes were estimated by using the plan area and median tailings depth. The tailings piles were delineated in the field by GPS coordinates and plotted on scaled USGS digital orthophotograph quadrangles (DOQs). The plan area was scaled from the DOQs in AutoCAD. The depth of tailings was measured in shovel pits and hand auger borings advanced through tailings.

The volume of tailings pile TP1 (Figure 6-9) was estimated from the plan area times the median tailings depth. A total of five shovel pits/hand auger borings were excavated in TP1. The tailings depth ranged from 1.0 to 4.4 feet with a median depth of 2.3 feet. The plan area of the tailings is 1.22 acres and the estimated tailings volume is 4,530 cubic yards.

The volume of tailings pile TP2 (Figure 6-9) was estimated from the plan area times the median tailings depth. A total of six shovel pits/hand auger borings were excavated in TP2. The tailings depth ranged from 0 to 3.8 feet with a median depth of 1.77 feet. The plan area of the tailings is 0.54 acres and the estimated tailings volume is 1,540 cubic yards.

The volume of tailings pile TP3 (Figure 6-9) was estimated from the plan area times the average tailings depth. A total of three shovel pits/hand auger borings were excavated in TP3. The tailings depth ranged from 2.5 to 3.0 feet with an average depth of 2.67 feet. The plan area of the tailings is 1.04 acres and the estimated tailings volume is 4,450 cubic yards. Tailings pile TP3 appeared to be deposited over old placer tailings piles. Because of the presence of the placer piles, the tailings depth is expected to be highly variable, which could significantly affect the volume estimate. Therefore, the volume of 4,450 cubic yards is probably conservatively high.

A small volume of tailings is present within the Drumlummon mill foundation. The tailings are present on the main vat level of the foundation and are visually estimated to be less than 50 cubic yards.

6.1.3.2 Tailings Pile Geology

The Drumlummon millsite tailings piles consist of predominantly light tan to light brown silty sand to sand. Lesser types include clayey sand, sandy clay and clay. Some red-orange to reddish brown oxidation is evident generally as streaks within the tailings. The native soils beneath the tailings piles are composed of brown sandy loam and rock. In the area of tailings pile TP3, the tailings appear to be deposited upon placer tailings.

A small volume of mill tailings are located on the lower foundation bench of the former Drumlummon mill. The character of the support foundations in this area suggest that vat leach tanks were probably located at this level in the mill and the tailings may be residual spillage during mill operations. The composite sample chemistry results for this tailings would support the vat leach interpretation for the data indicate elevated total cyanide concentration (24.8 mg/Kg) in the tailings. The tailings consist of white to tan silty sand containing variable yellow brown to red brown FeOx.

6.1.3.3 Tailings Pile Metals/pH Chemistry Results

Representative tailings samples were collected from shovel and/or hand auger borings. The number of samples collected were limited because of the small volume of these tailings relative to the other tailings areas. Individual samples were collected based on similar geologic characteristics. Five composite tailings samples were collected from the Drumlummon millsite tailings piles for XRF screening and laboratory analysis. The XRF results are compiled with the Drumlummon tailings in Appendix B and the laboratory data are summarized in Table 6-1 and contained in Appendix C. The quantitative laboratory data are separated from the main Drumlummon tailings to allow comparison of the results for these two separate tailings areas.

The Drumlummon millsite tailings pH is alkaline ranging from 7.3 to 8.2 standard units (SU). The tailings mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: As 28.0 mg/Kg (1.3x), Cu 97.6 mg/Kg (2.9x), Hg 4.1 mg/Kg (>8.2x), Pb 117.2 mg/Kg (10.4x), Zn 181 mg/Kg (2.6x) and total cyanide 5.70 mg/Kg. Cadmium was not detected and other analyte concentrations where only a single analysis was performed include: Ag 8 mg/Kg, Ba 88 mg/Kg, Cr 11 mg/Kg, Fe 10,600 mg/Kg, Mn 474 mg/Kg, Ni <5 mg/Kg, and Sb 10 mg/Kg. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Hg and Pb. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 5.7 mg/Kg and a maximum concentration of 24.8 mg/Kg is elevated. Only Ag concentration exceeded three times the average background soil concentration and with the exception of Ag and Sb, all of the single sample element concentrations were below the mean concentration for background soil.

The chemistry of the Drumlummon millsite tailings indicates that these tailings are generally more elevated in the analytes of concern relative to the main Drumlummon tailings. Mercury concentrations up to 9 mg/Kg and total cyanide up to 24.8 mg/Kg were significantly elevated relative to the concentrations of ≤ 1 mg/Kg Hg and <0.5 mg/Kg total cyanide in the main Drumlummon tailings. The mean concentrations for As, Cu, Pb and Zn are also elevated in the millsite tailings relative to the main Drumlummon tailings, but even so, these are low contaminant concentrations compared to most tailings sites.

6.1.4 Upper Pond Area

The Upper Pond Area tailings pile is located in the SE¼ Section 34, Township 12 North and Range 5 West, Montana Principal Meridian (Figure 1-1). Some of the Upper Pond Area tailings were probably generated from the Goldsil mill operations in the 1970's. A tailings dam is constructed along the southeastern boundary and is tied into placer tailings berms to form an impoundment into which the tailings were deposited. The tailings dam is constructed of native materials which appear to have been excavated from an open cut immediately to the southeast of the tailings pond. The tailings are moderately well vegetated with grasses, sagebrush some willows and weeds.

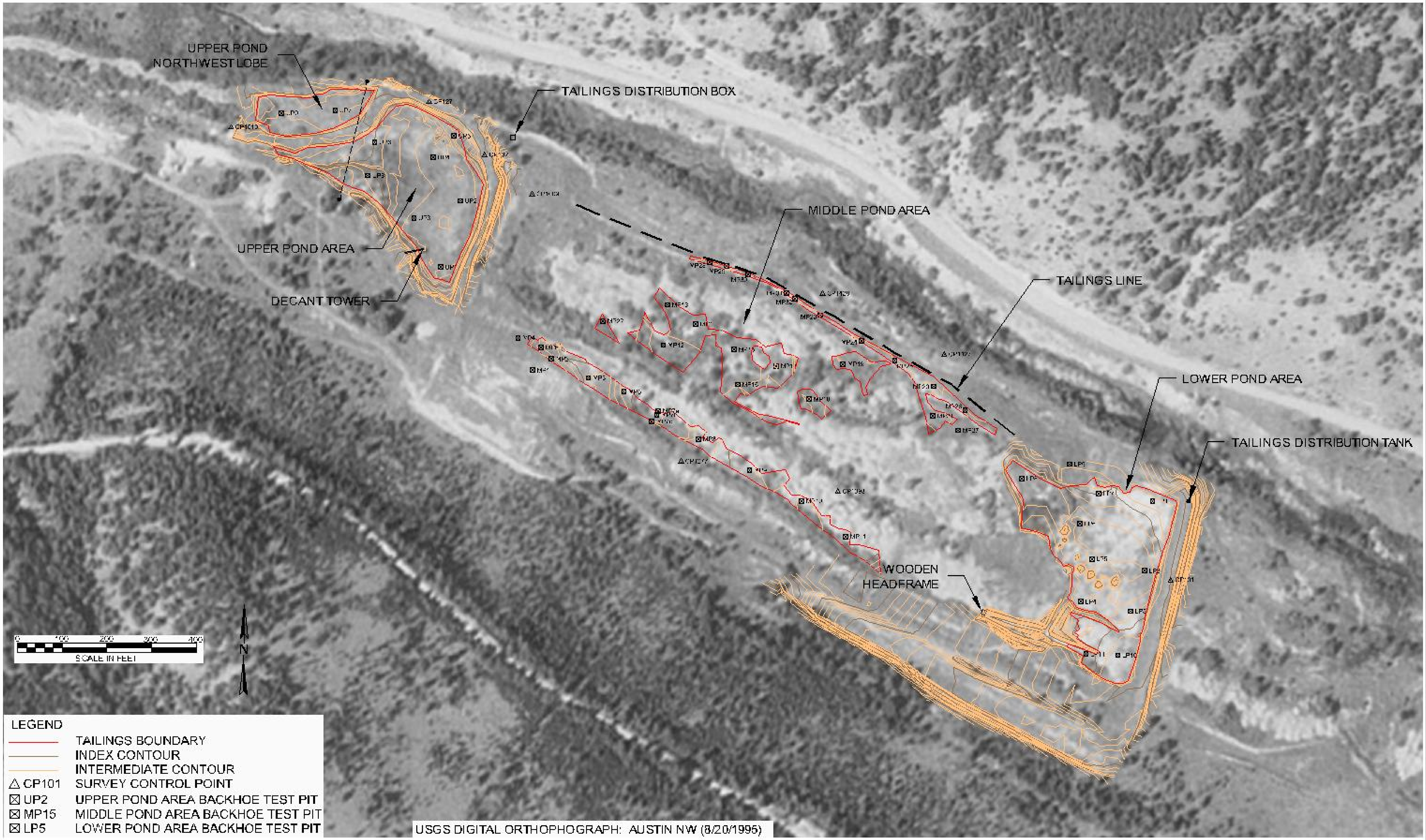
6.1.4.1 Tailings Pile Volume Estimate

The location of the Upper, Middle and Lower Pond Areas are superimposed on an aerial photograph and are shown on Figure 6-10. A detailed survey of the Upper Pond tailings area was completed and the topographic map is shown on Figure 6-11. The Upper Pond area tailings volume was estimated using the detailed topographic survey of the tailings surface and the test pit data. The test pit data were used to evaluate the depth of the tailings and the elevation of the native surface. The native surface elevations were plotted and the native surface below the tailings (Figure 6-12) was reconstructed into a surface model that fit the test pit data and topography surrounding the tailings. Eagle Point Civil/Survey 2002 software was used to triangulate and contour the native surface model. The contoured native surface was then evaluated to make sure that it was a reasonable representation of what the pre-tailings deposition surface may have looked like.

The tailings volume was calculated using the Eagle Point prismoidal method as described in Section 6.1.1. The estimated volume of the Upper Pond tailings is 17,400 cubic yards for the main tailings and 3,320 cubic yards for a smaller lobe located northwest of the main tailings. The tailings plan areas are 1.79 and 0.44 acres for the main tailings and northwest lobe, respectively. The average tailings depths are 6.03 and 4.72 feet for the main tailings and northwest lobe, respectively. The maximum tailings thickness measured in the test pits was 10.5 feet. A total of 8 test pits and one hand auger boring were excavated in the Upper Pond tailings. Tailings depth contours for the Upper Pond tailings are shown on Figure 6-12.

6.1.4.2 Tailings Pile Geology

The tailings in the Upper Pond Area predominantly consist of very fine grained to fine grained, white to tan silty clay and clayey silt. The fine grained, floury texture of the tailings is a source for dust emissions if wind conditions are right when the tailings are disturbed. Lesser fine grained sand tailings may be present and some bluish gray to light green clay tailings slimes were observed in the thicker tailings zones, i.e. in test pit UP8. Orange brown to red brown FeOx was observed in some of the tailings and native soils. The tailings are commonly banded with thin layers which appear to be more silt or clay rich. The tailings range from dry to very moist. Based on the vegetation pattern, they may contain more water during higher precipitation periods. The native soils consist of dark brown sand and silt with gravel. Angular to subangular rock or rounded cobbles are present in some of the native soils intersected in test pits.



LEGEND

- TAILINGS BOUNDARY
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- △ CP101 SURVEY CONTROL POINT
- ⊠ UP2 UPPER POND AREA BACKHOE TEST PIT
- ⊠ MP15 MIDDLE POND AREA BACKHOE TEST PIT
- ⊠ LP5 LOWER POND AREA BACKHOE TEST PIT

NO	REVISION DESCRIPTION	BY	DATE

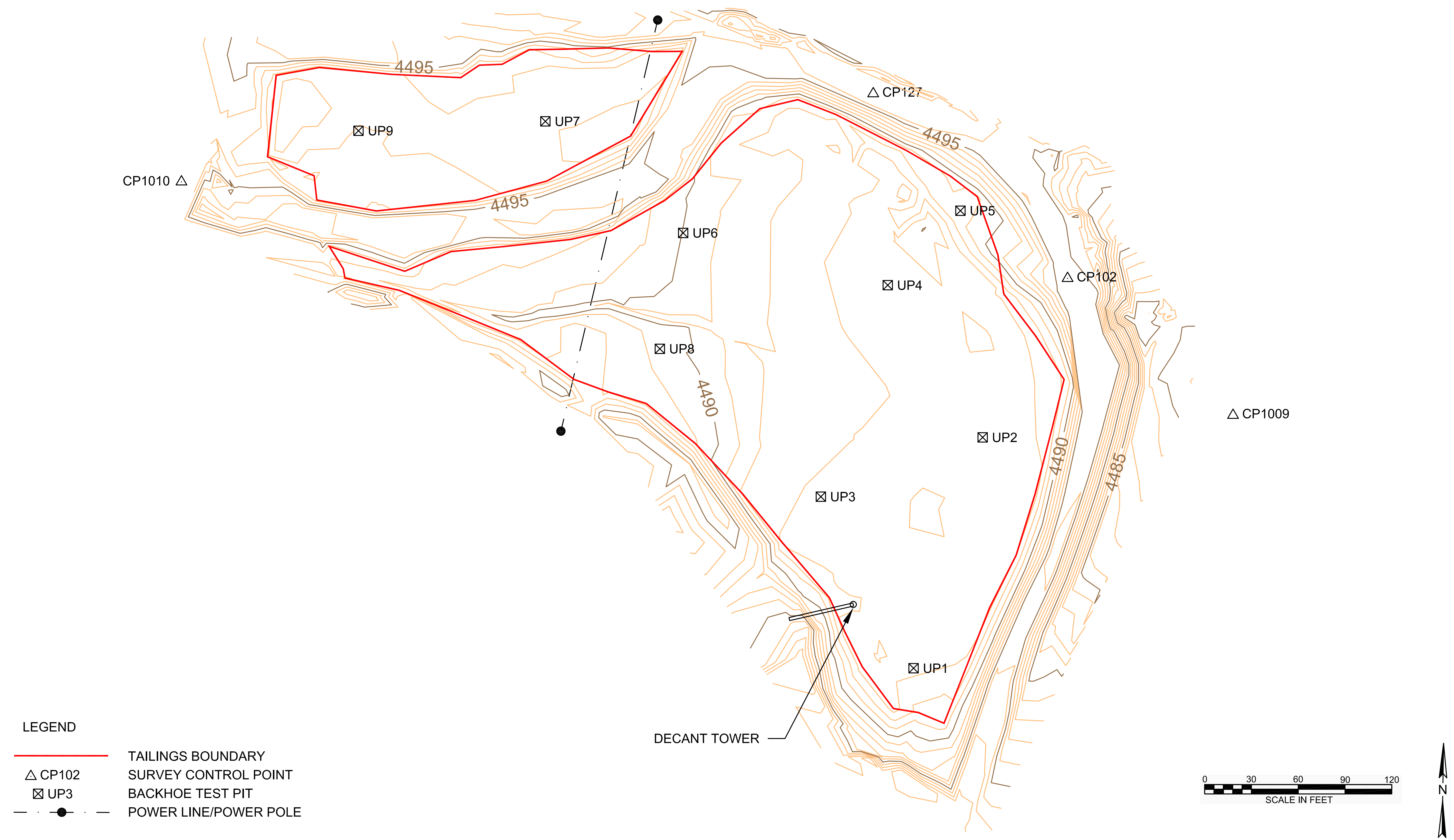
DESIGN: | DRAWN: KSR | CHECKED: CRS
APPROVED: | DATE: 9/2002 | JOB NO: A1234
SCALE: AS SHOWN | FILENAME: A1234Ponds.dwg

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

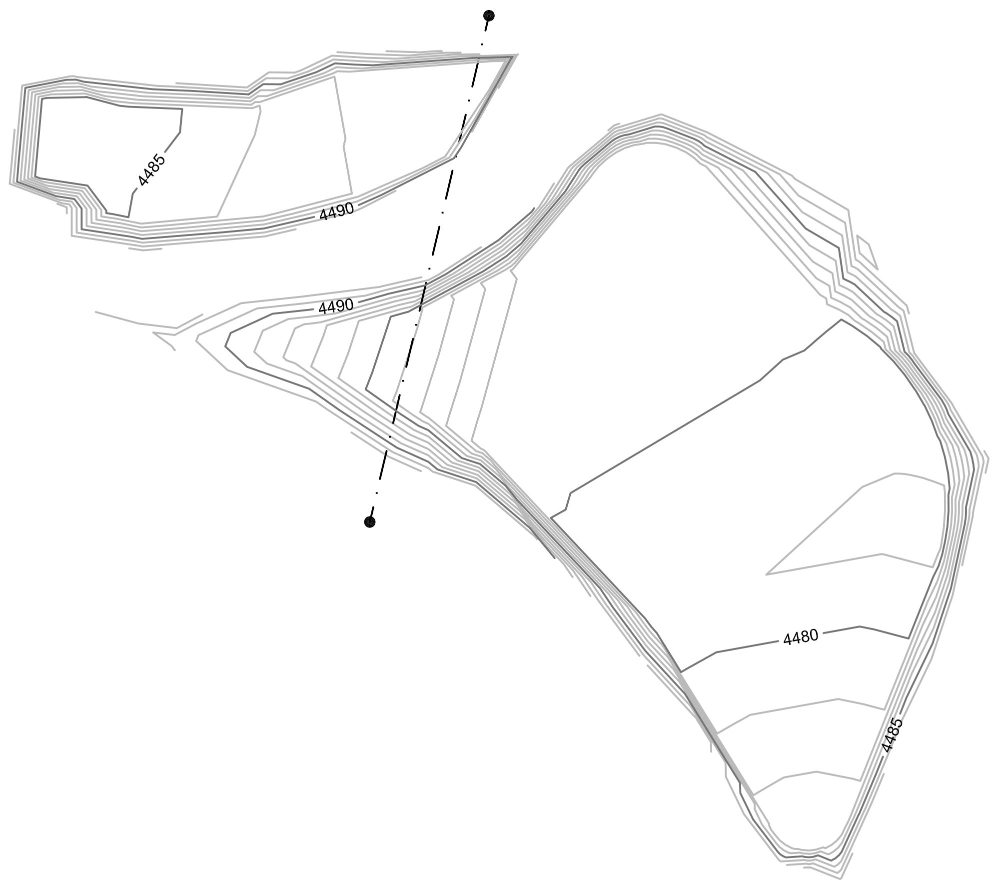
Olympus Technical Services, Inc.

AERIAL PHOTOGRAPH OF THE UPPER, MIDDLE AND LOWER POND AREAS

FIGURE 6-10



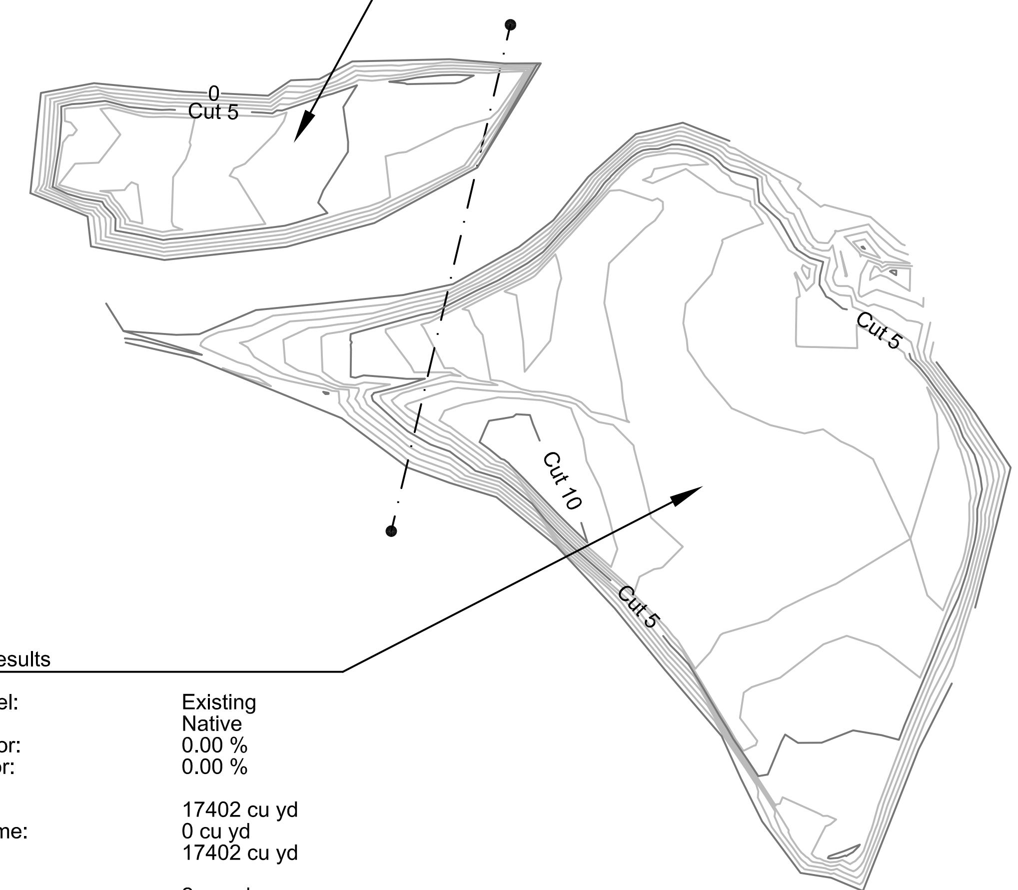
NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	TOPOGRAPHIC MAP OF THE UPPER POND AREA	FIGURE 6-11
				APPROVED:	DATE: 8/2002	JOB NO: A1284				
				SCALE: AS SHOWN	FILENAME: A1284UP.dwg					



PROJECTED NATIVE SURFACE

0 50 100 150 200
SCALE IN FEET

N



Prismoidal Volume Results

Original Surface Model:	Existing
Final Surface Model:	NWnative
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	3315 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	3315 cu yd
Raw Fill Volume:	0 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	0 cu yd

Prismoidal Volume Results

Original Surface Model:	Existing
Final Surface Model:	Native
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	17402 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	17402 cu yd
Raw Fill Volume:	2 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	2 cu yd

TAILINGS DEPTH CONTOURS

0 50 100 150 200
SCALE IN FEET

N

NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: CRS
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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

UPPER POND AREA
PROJECTED NATIVE SURFACE
AND TAILINGS DEPTH CONTOURS

FIGURE
6-12

6.1.4.3 Tailings Pile Metals/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from test pit walls or from grab samples collected from the test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Fifteen tailings samples and two representative composite tailings samples were collected from the Upper Pond Area tailings for XRF screening. In addition, seven native soil samples and one composite native soil were collected for XRF screening. The XRF results are contained in Appendix B. The Upper Pond Area tailings XRF mean concentration results for the principal elements of interest are as follows: As (45.6 ppm), Cd (no detection), Cu (137.8 ppm), Fe (9,661.8 ppm), Hg (134.4 ppm), Pb (308.8 ppm), Mn (559.2 ppm), and Zn (523.1 ppm). Laboratory analytical data for the two tailings and one native soil composite samples collected from the Upper Pond Area tailings are summarized in Table 6-1 and contained in Appendix C. A limited laboratory analytical suite consisting of pH, As, Cd, Cu, Hg, Pb, Zn and total cyanide was used for the Upper Pond Area tailings. These tailings were identified during the Phase I reconnaissance work in the Silver Creek Drainage Project and were analyzed according to the Phase I work analytical protocol.

The tailings pH is alkaline ranging from 7.9 to 8.0 standard units (SU). The mean concentration and mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: As 40.5 mg/Kg (1.9x), Cd 3.5 (7x), Cu 232.5 mg/Kg (6.8x), Hg 86.0 mg/Kg (>172x), Pb 247.0 mg/Kg (21.9x), Zn 510.0 mg/Kg (7.4x) and total cyanide 0.8 mg/Kg. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd and Hg. Cadmium was not detected and the mean concentration for Hg is significantly higher via XRF method.

The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Cd, Cu, Hg, Pb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 0.8 mg/Kg and a maximum concentration of 1.0 mg/Kg are slightly elevated.

The XRF and laboratory data for native soils collected below the tailings indicate that As and Hg concentrations are present near the contact zone with tailings. Although As concentrations are commensurate with the tailings, they are considered low soil concentrations at generally less than 100 mg/Kg. Although mercury was detected in half of the XRF samples, it was considered no detection based upon the analytical instrument data validation method. Mercury was, however, detected in the single composite sample collected for quantitative laboratory analysis from test pits UP1, UP2, UP4 and UP7. Although the concentration of 25 mg/Kg is lower than the mean concentration of the Upper Pond Area tailings, it is significantly elevated in the native soils. The mercury could be related to placer tailings which are widespread in this area of the Silver Creek drainage. Although mercury concentrations in placer tailings can be highly variable, mercury was detected in most of the placer tailings sampled during the Phase I reconnaissance work (DEQ-MWCB/Olympus, 2003). The native soil composite sample base metal concentrations for Cu, Pb and Zn are generally low and total cyanide was not detected.

6.1.5 Middle Pond Area

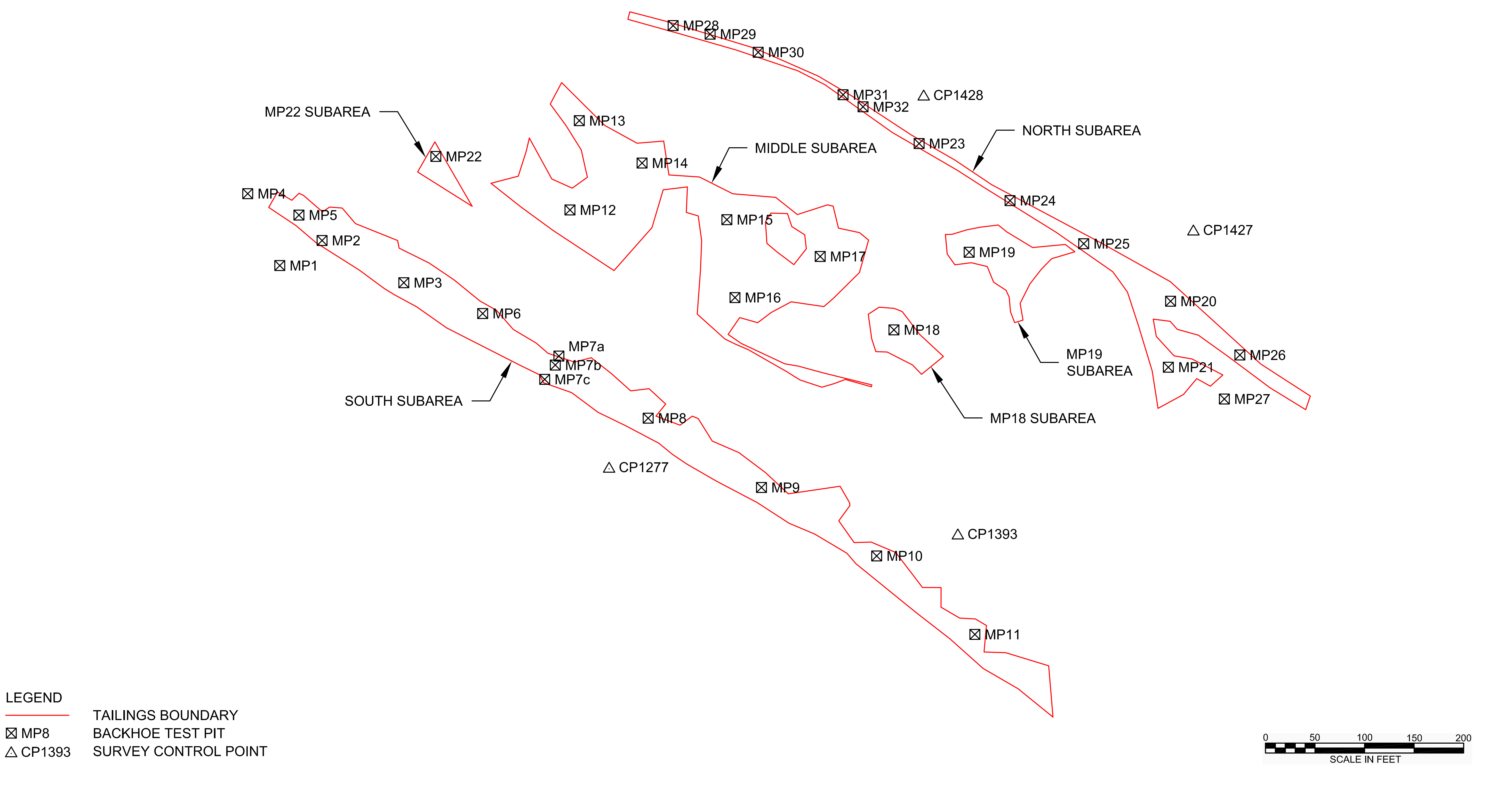
The Middle Pond Area tailings pile is located in the SE¼ Section 34, Township 12 North and Range 5 West and NE¼ Section 3, Township 11 North and Range 5 West, Montana Principal Meridian (Figure 1-1). Some of the Middle Pond Area tailings were probably generated from the Goldsil mill operations in the 1970's. The tailings were deposited within an area of placer tailings and seem to have been deposited in topographic low areas within the placer tailings piles. There is field evidence that indicates the placer piles have been disturbed. In some areas the placer tailings have been dozed into berms, while in other areas they have been graded out. The berm configurations suggest that localized cells may have been created to provide for tailings impoundment. The Middle Pond Area tailings is generally well vegetated except for the processed placer tailings piles that are composed predominantly of rock.

6.1.5.1 Tailings Pile Volume Estimate

Tailings in the Middle Pond Area were deposited in several areas between existing overburden and processed placer tailings piles (Figure 6-10). The Middle Pond and Lower Pond areas are separated by processed placer tailings piles that have been graded out. Tailings along the northern perimeter of the Middle Pond are associated with spillage from the tailings line between the Upper Pond and Lower Pond dams and are primarily contained in a ditch adjacent to the line. The tailings along the southern perimeter of the Middle Pond area were most likely spilled or discharged starting approximately 200 feet from the southern end of the Upper Pond dam. These tailings were deposited in a narrow, linear configuration between placer tailings piles.

Tailings in the central portion of the Middle Pond are found in pockets between placer tailings piles (Figure 6-10). The origin of deposition of these tailings was not visible in the field. Theories as to how these tailings were deposited include: 1) the tailings were deposited via another discharge line that has been removed, or 2) tailings could have overflowed from the north and south Middle Pond tailings areas in gaps between the hummocky placer piles. The first theory is more likely. A temporary pipe could have been run from the distribution box on the Upper Pond dam to the central portion of the Middle Pond area to discharge the tailings. This could also be how the tailings along the southern Middle Pond perimeter were discharged. The second theory is possible but less likely. It is conceivable that tailings slurry could pond up and flow through gaps in the placer tailings piles; however, direct evidence of this was not observed. A small rock berm was observed near the west end of the southern Middle Pond tailings area. It is possible that a gap in the placer tailings piles could have existed prior to placement of this berm; however, the Middle Pond tailings deposition areas appeared in the field to be completely separated. The Middle Pond tailings were identified in six subareas, consisting of three main and three smaller, isolated deposition zones. The tailings subareas are shown on Figure 6-13 and are designated as the following subareas: North, Middle, South, MP18, MP19, and MP22.

The volume of tailings in the North subarea was estimated from the plan area times the median tailings depth. A total of 11 test pits were excavated in the North subarea. The tailings depth ranged from 0.3 to 6.6 feet, with a median depth of 1.6 feet. The plan area of the North subarea is 0.30 acres and the estimated tailings volume is 780 cubic yards.



				DESIGN:	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	MIDDLE POND TAILINGS AREA	FIGURE 6-13
				APPROVED:	DATE: 9/2002	JOB NO: A1284				
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The volume of tailings in the Middle subarea was estimated from the plan area times the median tailings depth. A total of six test pits were excavated in the Middle subarea. The tailings depth ranged from 1.2 to 4.7 feet, with a median depth of 3.6 feet. The plan area of the Middle subarea is 0.76 acres and the estimated tailings volume is 4,390 cubic yards.

The volume of tailings in the South subarea was estimated from the plan area times the median tailings depth. A total of 11 test pits were excavated in the South subarea. The tailings depth ranged from 1.0 to 7.4 feet, with a median depth of 4.6 feet. The plan area of the Middle subarea is 0.72 acres and the estimated tailings volume is 5,330 cubic yards.

The volume of tailings in the MP18 subarea was estimated from the plan area times the tailings depth. One test pit (MP18) was excavated in the MP18 subarea, with a tailings depth of 2.1 feet. The plan area of the MP18 subarea is 0.052 acres and the estimated tailings volume is 180 cubic yards.

The volume of tailings in the MP19 subarea was estimated from the plan area times the tailings depth. One test pit (MP19) was excavated in the MP19 subarea, with a tailings depth of 1.7 feet. The plan area of the MP19 subarea is 0.11 acres and the estimated tailings volume is 300 cubic yards.

The volume of tailings in the MP22 subarea was estimated from the plan area times the tailings depth. One test pit (MP22) was excavated in the MP22 subarea, with a tailings depth of 3.4 feet. The plan area of the MP22 subarea is 0.024 acres and the estimated tailings volume is 300 cubic yards.

6.1.5.2 Tailings Pile Geology

The mill tailings appear to have in-filled around and over placer tailings piles in the Middle Pond Area. The larger placer tailings piles are predominantly rock with little fine-grained sediment. They are generally cone-shaped piles where they have not been disturbed by dozing activities. The mill tailing sediments are located in topographically low areas within the placer tailings. They are predominantly characterized as white to light tan very fine to fine grained silts to sandy silts with variable banding caused by thin layers. These tailings are generally dry and exhibit a floury texture. Lesser tan, silty clays and clayey silts may contain some iron oxide and moisture. The more clayey-rich tailings occur in thin layers within the silt tailings or near the contact with native soil at depth.

6.1.5.3 Tailings Pile Metals/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from test pit walls or from grab samples collected from the test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Fourteen tailings samples and four representative composite tailings samples were collected from the Middle Pond Area tailings for XRF screening. In addition, three native soil samples and one composite native soil were collected for XRF screening. The XRF results are contained in Appendix B. The Middle Pond Area tailings XRF mean concentration results for the principal elements of interest are as follows: As (40.8 ppm), Cd (no detection), Cu (no detection), Hg (46.1 ppm), Pb (83.1 ppm), Mn (no detection), and Zn (201.7 ppm).

Laboratory analytical data for the two tailings and one native soil composite samples collected from the Middle Pond Area tailings are summarized in Table 6-1 and contained in Appendix C. A limited laboratory analytical suite consisting of pH, As, Cd, Cu, Hg, Pb, Zn and total cyanide was used for the Middle Pond Area tailings. These tailings were identified during the Phase I reconnaissance work in the Silver Creek Drainage Project and were analyzed according to the Phase I work analytical protocol. The tailings pH is alkaline ranging from 7.4 to 7.7 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: As 23.5 mg/Kg (1.1x), Cd 1.9 (>3.8x), Cu 103.8 mg/Kg (3.0x), Hg 18.8 mg/Kg (>37.6x), Pb 110.8 mg/Kg (9.8x), Zn 217.3 mg/Kg (3.2x) and total cyanide 9.7 mg/Kg. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd, Cu and Hg. Cadmium and Cu were not detected and the mean concentration for Hg is significantly higher via XRF method.

The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Cd, Cu, Hg, Pb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 9.7 mg/Kg and a maximum concentration of 23.9 mg/Kg are significantly elevated.

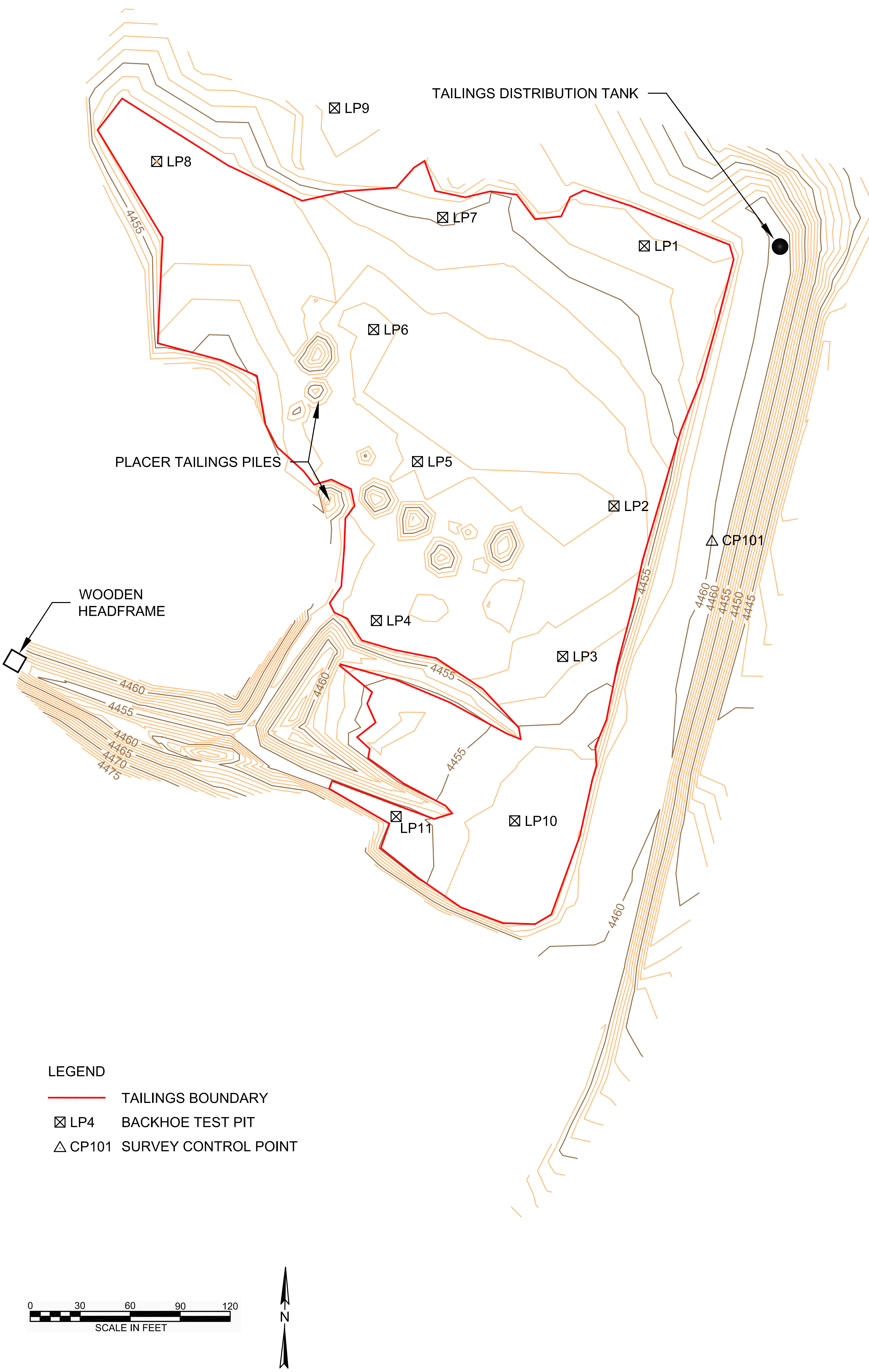
The XRF and laboratory data for native soils collected below the tailings indicate that arsenic concentrations are present near the contact zone with tailings. Although arsenic concentrations are slightly elevated relative to the tailings, they are considered low soil concentrations at less than 100 mg/Kg. Mercury was not detected in the composite native soil sample collected from test pits MP3, MP6 and MP9. The base metals, Cu, Pb and Zn are all near background soil concentrations for these elements. Total cyanide was detected in the native soil composite at 2.1 mg/Kg. Although this concentration is below the tailings mean concentration, it is elevated and suggests some movement of cyanide into the native soil contact zone.

6.1.6 Lower Pond Area

The Lower Pond Area tailings pile is located in the NE¼ Section 3, Township 11 North and Range 5 West, Montana Principal Meridian (Figure 1-1). The Lower Pond Area tailings were probably generated from the Goldsil mill operations in the 1970's. A tailings dam is constructed along the eastern boundary and is tied into placer tailings berms to form an impoundment into which the tailings were deposited. Placer tailings piles comprised of rock with very little fine grained sediment form conspicuous islands within the tailings impoundment. These islands suggest that the Lower Pond Area tailings are deposited upon placer tailings verses native soils. The tailings dam is constructed of native materials which appear to have been excavated from an open cut immediately to the southwest of the tailings pond. Although there are areas barren of vegetation, the tailings are generally moderately well vegetated with grasses, sagebrush, some willows and weeds.

6.1.6.1 Tailings Pile Volume Estimate

The location of the Lower Pond Area tailings is superimposed on an aerial photograph and is shown on Figure 6-10. A detailed survey of the Lower Pond tailings area was completed and the topographic map is shown on Figure 6-14. The tailings volume was estimated using the



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SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

LOWER POND AREA

FIGURE 6-14

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detailed topographic survey of the tailings surface and the test pit data. The test pit data were used to evaluate the depth of the tailings and the elevation of the native surface. The native surface elevations were plotted and native surface below the tailings (Figure 6-15) was reconstructed into a surface model that fit the test pit data and topography surrounding the tailings. Eagle Point Civil/Survey 2002 software was used to triangulate and contour the native surface model. The contoured native surface was then evaluated to make sure that it was a reasonable representation of what the pre-tailings deposition surface may have looked like.

The estimated volume of the tailings is 20,710 cubic yards including an area of placer tailings piles that are mostly covered with tailings. Only the tops of the placer tailings piles are visible and form small "islands" within the mill tailings deposits. The exposed portions of the placer tailing piles were used to estimate the side slopes of the piles. These slopes were projected to intersect the triangulated native surface. A surface model of the placer piles was triangulated from these projected slopes. The volume of placer tailings piles within the Lower Pond tailings are estimated at 3,040 cubic yards using Eagle Point surface models. The tailings volume excluding the placer tailings piles is 17,670 cubic yards.

The tailings plan area is 1.77 acres, excluding the placer pile area, and the average tailings depth is 6.20 feet. The maximum tailings thickness measured in the test pits was 14.0 feet. A total of 11 test pits were excavated in the Lower Pond tailings. Tailings depth contours for the Lower Pond tailings are shown on Figure 6-15.

6.1.6.2 Tailings Pile Geology

The tailings contained in the Lower Pond Area consist predominantly of beige to light tan silts and fine grained sands with lesser brown and gray clays. The fine grained silt and sand tailings exhibit a floury texture. Iron oxide is variable and most commonly associated with the more clay-rich lenses, as is increased moisture content. The native materials beneath the tailings are variable and consist of rock-rich placer tailings and/or brown sand and gravel with rock.

The principal discharge point for tailings into the Lower Pond Area appears to have been near the northeastern corner of the tailings dam. There is a steel distribution tank and associated PVC piping which were used to discharge tailings into the pond from the main tailings line. Field evidence of sections of metal-banded wooden pipe partially filled with tailings suggest that the main tailings line most likely ran along the northern boundary of the Lower Pond Area (Figure 6-10).

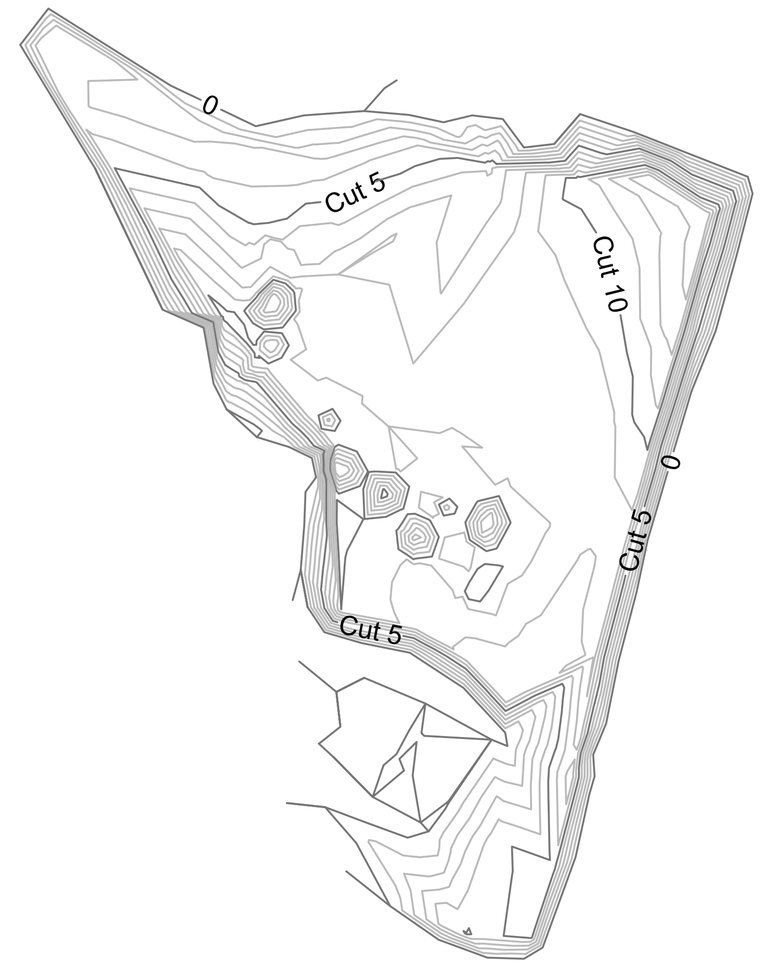
6.1.6.3 Tailings Pile Metals/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from test pit walls or from grab samples collected from the test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Nineteen tailings samples and two representative composite tailings samples were collected from the Lower Pond Area tailings for XRF screening. The XRF results are contained in Appendix B. The Lower Pond Area tailings XRF mean concentration results for the principal elements of interest are as follows: As (37.2 ppm), Cd (no detection), Cu (74.3 ppm), Hg (150.6 ppm), Pb (108.5 ppm), Mn (357.9 ppm), and Zn (280.0 ppm).

PROJECTED NATIVE SURFACE

0 50 100 150 200
SCALE IN FEET

N



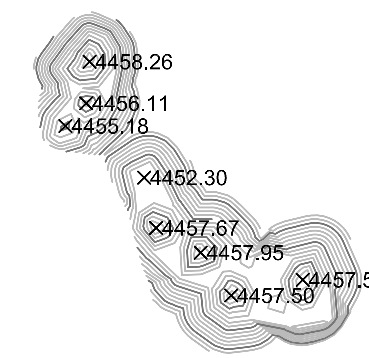
Prismoidal Volume Results

Original Surface Model:	Existing
Final Surface Model:	Bottom Tailings
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	20711 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	20711 cu yd
Raw Fill Volume:	19 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	19 cu yd

TAILINGS DEPTH CONTOURS

0 50 100 150 200
SCALE IN FEET

N



Prismoidal Volume Results

Original Surface Model:	PlacerPiles
Final Surface Model:	Bottom Tailings
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	3045 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	3045 cu yd
Raw Fill Volume:	0 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	0 cu yd

PLACER ROCK ISLAND CONTOURS

0 50 100 150 200
SCALE IN FEET

N

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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

LOWER POND PROJECTED NATIVE SURFACE, TAILINGS DEPTH CONTOURS AND PLACER ROCK ISLAND CONTOURS

FIGURE 6-15

Laboratory analytical data for the two composite samples collected from the Lower Pond Area tailings are summarized in Table 6-1 and contained in Appendix C. A limited laboratory analytical suite consisting of pH, As, Cd, Cu, Hg, Pb, Zn and total cyanide was used for the Lower Pond Area tailings. These tailings were identified during the Phase I reconnaissance work in the Silver Creek Drainage Project and were analyzed according to the Phase I work analytical protocol. The tailings pH is alkaline ranging from 8.0 to 8.1 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: As 28.0 mg/Kg (1.3x), Cd 2.0 (>4.0x), Cu 125.0 mg/Kg (3.7x), Hg 32.0 mg/Kg (>64x), Pb 119.5 mg/Kg (10.6x), Zn 255.5 mg/Kg (3.7x) and total cyanide 3.5 mg/Kg. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd and Hg. Cadmium was not detected and the mean concentration for Hg is significantly higher via XRF method.

The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Cd, Cu, Hg, Pb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 3.5 mg/Kg and a maximum concentration of 5.0 mg/Kg are moderately elevated.

6.2 MILL TAILINGS PILES ACID-BASE ACCOUNTING RESULTS

The mill tailings in the Silver Creek Drainage area generally do not show much field evidence of acid rock drainage (ARD) problems. The following observations support the non-acid generating character of the mill tailings:

- Tailings are generally moderately to well vegetated with a variety of plants and trees.
- Iron oxide is generally minor in most of the tailings with the exception of the Drumlummon tailings.
- Silver Creek, which either flows through or is in close proximity to the major mill tailing areas, does not exhibit ARD characteristics, i.e. low pH water, strong iron oxide staining of stream gravel/rock, and elevated metals in surface water.
- Paste pH data indicate that the mill tailings are alkaline.

Composite samples of mill tailings from the Goldsil tailings and the Drumlummon tailings were evaluated for static ABA methods to evaluate the acid generating potential and inherent neutralization capability of the tailings. The Goldsil tailings and the Drumlummon tailings represent the major sources of mill tailings in the Silver Creek Drainage Project area. A total of eleven composite samples were collected for ABA analyses at Energy Laboratories, Inc. The laboratory analytical results are contained in Appendix C and are summarized in Table 6-4. The ABA data indicate that the total sulfur concentrations in the mill tailings are low ranging from 0.03% to 0.06%. Low total sulfur concentrations limit the potential for ARD development. All of the composite samples show significant positive net ABA ranging from 64 to 109, indicating that the mill tailings are probably not acid generating. The inherent neutralization potential of the mill tailings is further corroborated by the XRF results for calcium that showed concentrations in the Goldsil tailings and Drumlummon tailings ranging from 0.8% to 3.7%. These data indicate that calcium carbonate ($CaCO_3$) concentrations may be as high as 9.2% in the tailings.

Table 6-4. Acid-Base Accounting Results For Mill Tailings and Waste Rock

Sample ID	Total Sulfur (%)	Pyritic Sulfur (%) HNO_3 Ext. S	Sulfate Sulfur (%) HCL Ext. S	Hot H_2O Ext. S (%)	Residual Sulfur (%)	Non-SO4 S (%)**	Calc AGP	Acid Gen Potential *	Neutraliz Potential *	Acid/Base Potential *
25-365-TP-12	0.06	0.03	<0.01	0.03	0.01	0.03	0.94	1	110	109
25-365-TP-13	0.06	0.04	<0.01	0.02	0.01	0.04	1.25	1	91	90
25-365-TP-14	0.06	0.03	0.01	0.01	0.01	0.05	1.56	2	100	98
25-365-TP-15	0.05	0.03	<0.01	0.01	0.01	0.04	1.25	1	78	77
25-365-TP-16	0.06	0.02	<0.01	0.03	0.01	0.03	0.94	1	80	79
25-365-TP-17	0.04	0.02	<0.01	0.02	<0.01	0.02	0.63	1	65	64
25-365-TP-18	0.04	0.02	<0.01	0.01	0.01	0.03	0.94	1	76	75
25-365-TP-19	0.06	0.05	<0.01	0.02	<0.01	0.04	1.25	1	92	91
25-024-TP-1	0.06	0.02	<0.01	0.02	0.02	0.04	1.25	1	110	109
25-024-TP-3	0.03	<0.01	0.02	0.01	<0.01	0.02	0.63	1	100	99
25-024-TP-4	0.03	0.02	<0.01	0.01	<0.01	0.02	0.63	1	93	92
25-024-WR5	0.08	0.07	<0.01	0.01	<0.01	0.07	2.19	2	160	158
25-024-WR6	0.10	0.08	<0.01	0.02	<0.01	0.08	2.50	3	78	75

* Tons of $CaCO_3$ equivalent per 1000 tons of material (Note: Energy Laboratories, Inc. reports ppt (parts per thousand) which is equivalent)
**Only Hot H_2O extractable sulfur considered sulfate sulfur

LEGEND

25-365-TP-12	25-365-TP-12 is a composite of GTDH-2 0-5;GTDH-4 0-5;GTDH-5 0-5
25-365-TP-13	25-365-TP-13 is a composite of GTDH-1 15-20;GTDH-6 15-20;GTDH-3 15-20
25-365-TP-14	25-365-TP-14 is a composite of GTDH-2 15-20;GTDH-4 15-20;GTDH-5 15-20
25-365-TP-15	25-365-TP-15 is a composite of GTDH-1 29-34;GTDH-6 30-35;GTDH-3 30-35
25-365-TP-16	25-365-TP-16 is a composite of GTDH-2 30-34;GTDH-4 30-33.1;GTDH-5 30-35
25-365-TP-17	25-365-TP-17 is a composite of GTDH-7 5-10;GTDH-8 5-10;GTDH-9 5-10
25-365-TP-18	25-365-TP-18 is a composite of GTDH-7 15-19.4;GTDH-8 15-20;GTDH-9 15-20
25-365-TP-19	25-365-TP-19 is a duplicate split of 25-365-TP-13
25-024-TP-1	25-024-TP-1 is a composite of DT-4 0-5.0;DT-12 4.2-6.4;DT-15 4.7-6.6
25-024-TP-3	25-024-TP-3 is a composite of DT-2 0-4.0;DT-8 0-5.8;DT-12 0-4.2:DT-15 0-4.7
25-024-TP-4	25-024-TP-4 is a composite of DT-1 4.8-7.8;DT-3 3.7-7.4;DT-5 0-8.9
25-024-WR5	25-024-WR5 is a composite of 25-SCD-WR1, WR2A & WR2B
25-024-WR6	25-024-WR6 is a composite of 25-SCD-WR3A, WR3B, WR3C, WR4A, WR4B & WR4C

6.3 MILL TAILINGS PILES TCLP RESULTS

Based on the laboratory analytical results for the mill tailings, splits of composite samples were selected for metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) Toxicity Characteristic Leaching Procedure (TCLP) analysis. Chemistry results for mill tailings show that mercury is the metal element of most concern in the Silver Creek Drainage Project area. Based on the laboratory analytical results, four composite mill tailings samples with elevated mercury concentrations (53 mg/Kg to 140 mg/Kg) were selected for TCLP analysis at Energy Laboratories in Billings, Montana.

The tailings TCLP laboratory analytical results are contained in Appendix C and are summarized in Table 6-5. The results indicate that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification. Selenium was the only analyte detected in the TCLP analyses for mill tailings and the concentrations were well within the regulatory limit.

6.4 DRUMLUMMON MINE/MILLSITE WASTE ROCK PILES (WR1-WR4)

The Drumlummon millsite and mine are located in Section 36, Township 11 North, Range 6 West, Montana Principal Meridian (Figure 1-1). The aerial photograph presented in Figure 6-16

provides more detail on the millsite and mine areas. The millsite and mine occur in steep mountainous terrain that is predominantly forested. A site investigation was made of the Drumlummon millsite and mine to characterize the waste sources and identify any physical hazards that may be present.

6.4.1 Waste Rock Pile Volume Estimate

Four waste rock piles (WR1 through WR4) were identified at the Drumlummon millsite and mine. Waste rock piles WR1 and WR2 are small piles associated with upper mine area, while the two largest piles, WR3 and WR4 occur in close proximity to the millsite. The latter piles appear to be underground development waste rock that most likely was trammed out from the main haulage level adit. The portal for this adit is located near the south boundary of waste rock pile WR4. The millsite and mine area waste rock piles were surveyed as part of the site topographic map surveys. These survey data were used to calculate volume estimates for the waste rock piles.

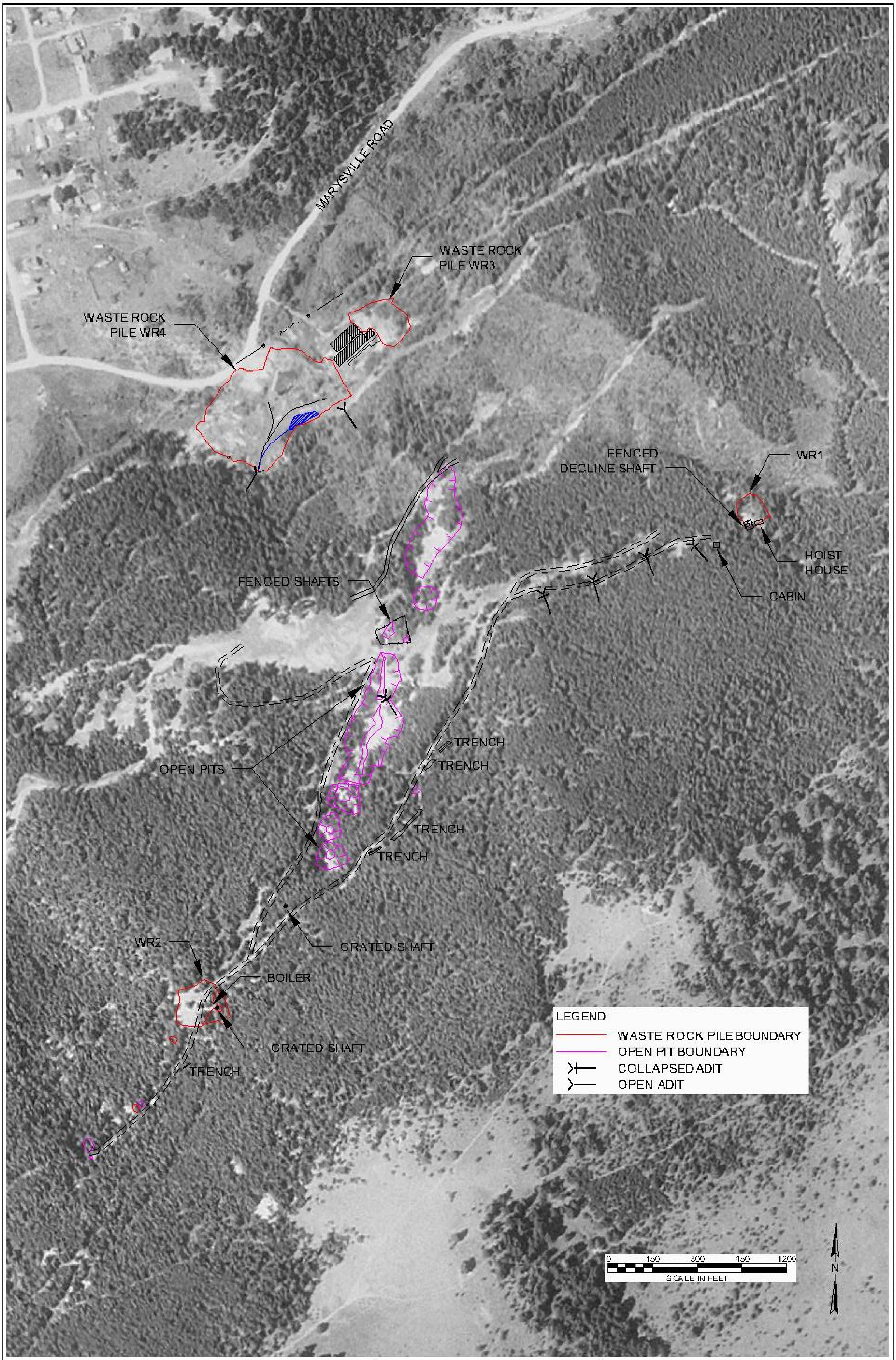
Waste rock pile WR1 is located near the east end of the Drumlummon mine area (Figure 6-16). A detailed topographic survey of WR1 was completed (Figure 6-17) and used to estimate the waste rock volume. The volume was calculated using Eagle Point surface models of the waste rock pile surface and the projected native surface below the pile. No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The projected native surface and depth contours are shown on Figure 6-18. The estimated volume of WR1 is 1,460 cubic yards. The plan area of WR1 is 0.19 acres and the average waste rock depth is 4.71 feet.

Table 6-5. TCLP Metals for Mill Tailings and Waste Rock

Sample ID	Ag (mg/L)	As (mg/L)	Ba (mg/L)	Cd (mg/L)	Cr (mg/L)	Hg (mg/L)	Pb (mg/L)	Se (mg/L)
25-365-TP-12	<0.5	<0.5	<10	<0.1	<0.5	<0.02	<0.5	0.2
25-365-TP-14	<0.5	<0.5	<10	<0.1	<0.5	<0.02	<0.5	0.2
25-365-TP-16	<0.5	<0.5	<10	<0.1	<0.5	<0.02	<0.5	0.2
25-SCD-TP-8	<0.5	<0.5	<10	<0.1	<0.5	<0.02	<0.5	<0.1
25-024-WR5	<0.5	<0.5	<10	<0.1	<0.5	<0.02	<0.5	<0.1
25-024-WR6	<0.5	<0.5	<10	<0.1	<0.5	<0.02	<0.5	<0.1
Regulatory Level	5	5	100	1	5	0.2	5	1

LEGEND

25-365-TP-12 is a composite of GTDH-2 0-5;GTDH-4 0-5;GTDH-5 0-5
25-365-TP-14 is a composite of GTDH-2 15-20;GTDH-4 15-20;GTDH-5 15-20
25-365-TP-16 is a composite of GTDH-2 30-34;GTDH-4 30-33.1;GTDH-5 30-35
25-SCD-TP-8 is a composite of UP2 5.5-7;UP3 5.1-7.4:UP4 0-6.1;UP8 9.4-10.5
25-024-WR5 is a composite of 25-SCD-WR1, WR2A & WR2B
25-024-WR6 is a composite of 25-SCD-WR3A, WR3B, WR3C, WR4A, WR4B & WR4C



Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	AERIAL PHOTOGRAPH OF THE DRUMLUMMON MINE AND MILLSITE AREAS	FIGURE 6-16

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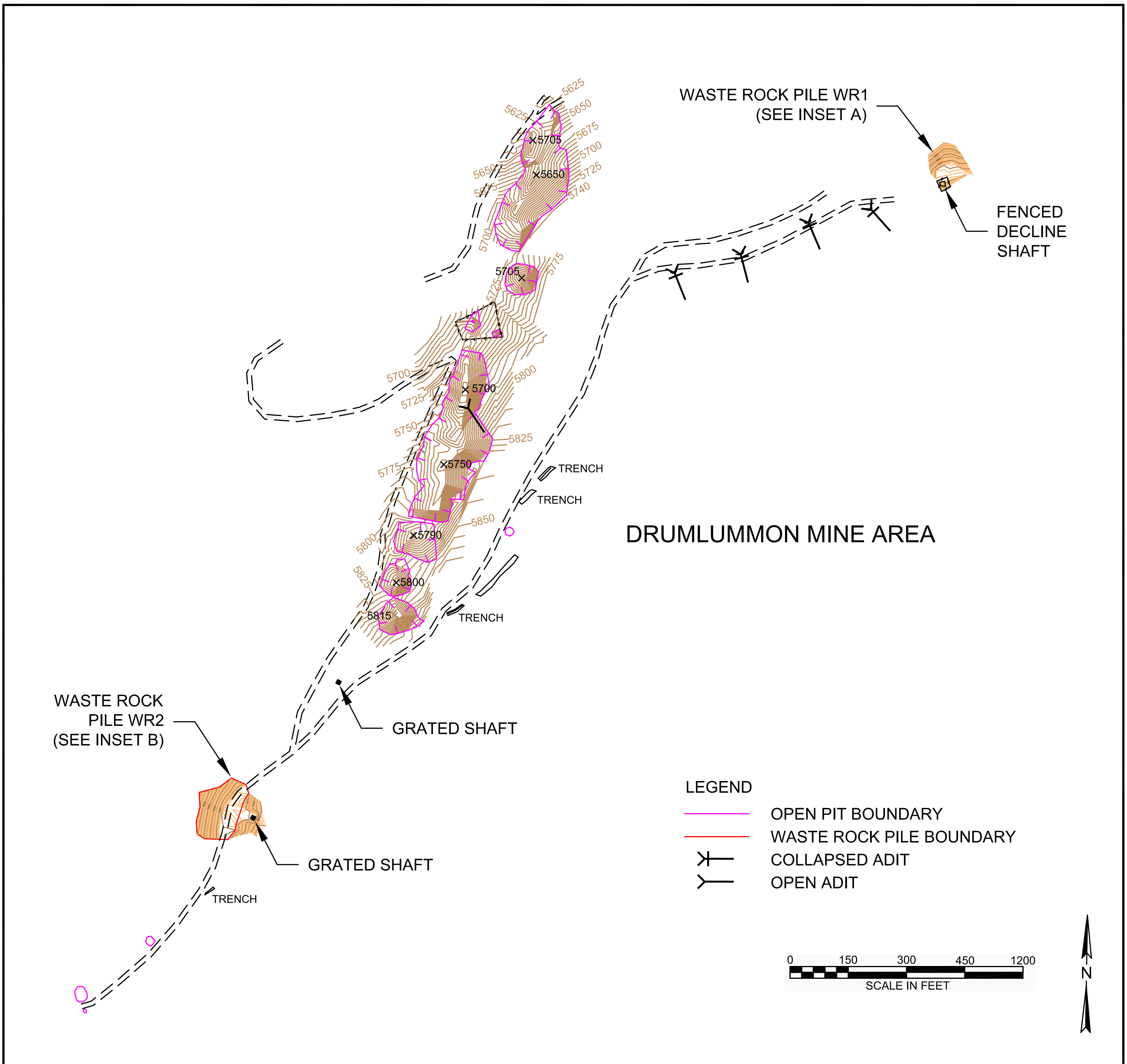
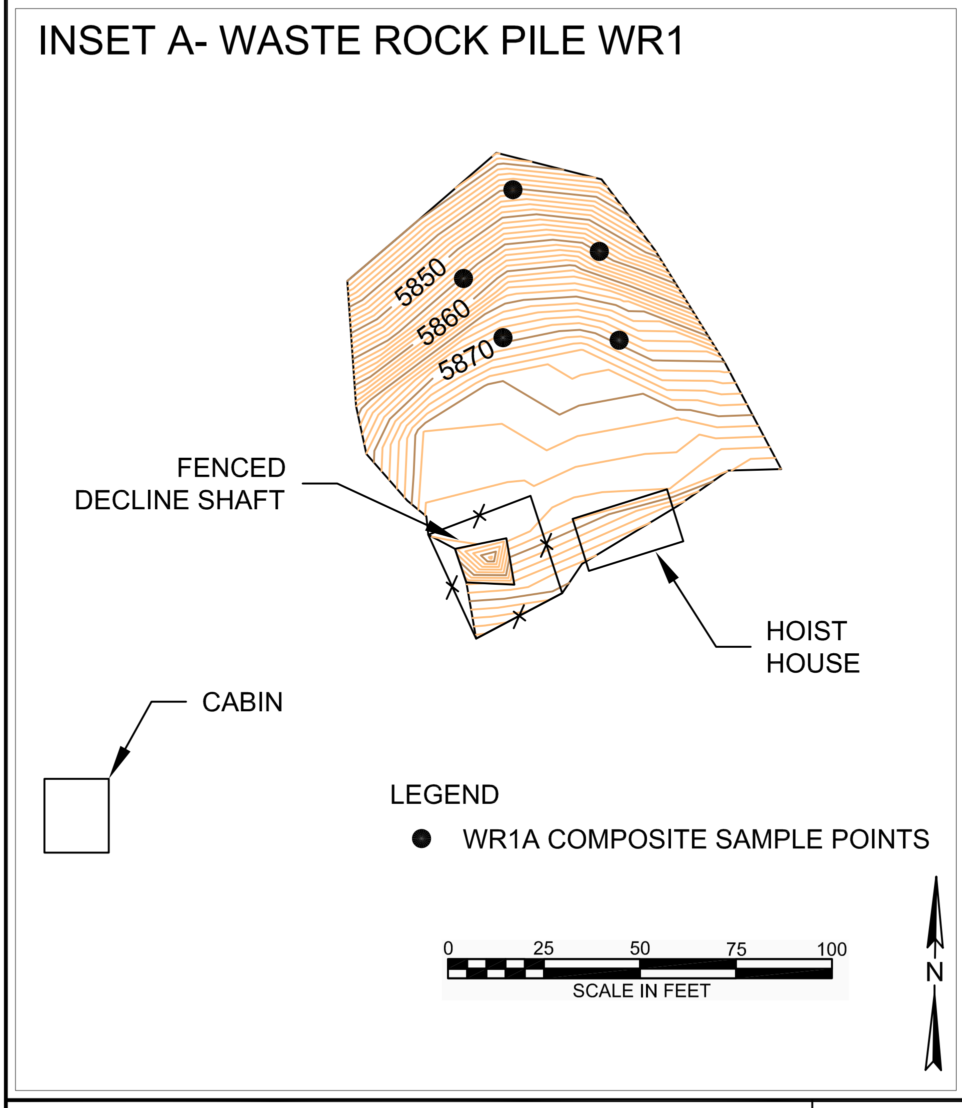
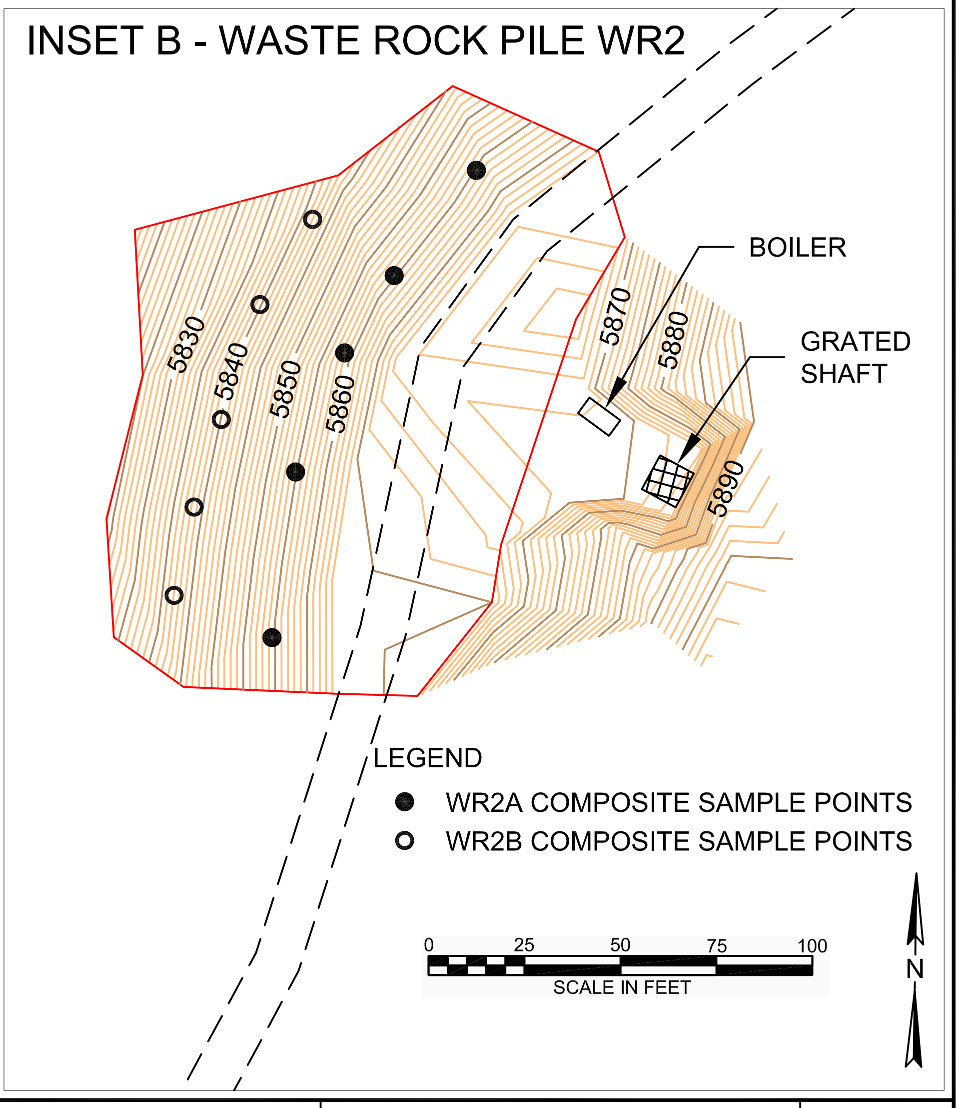
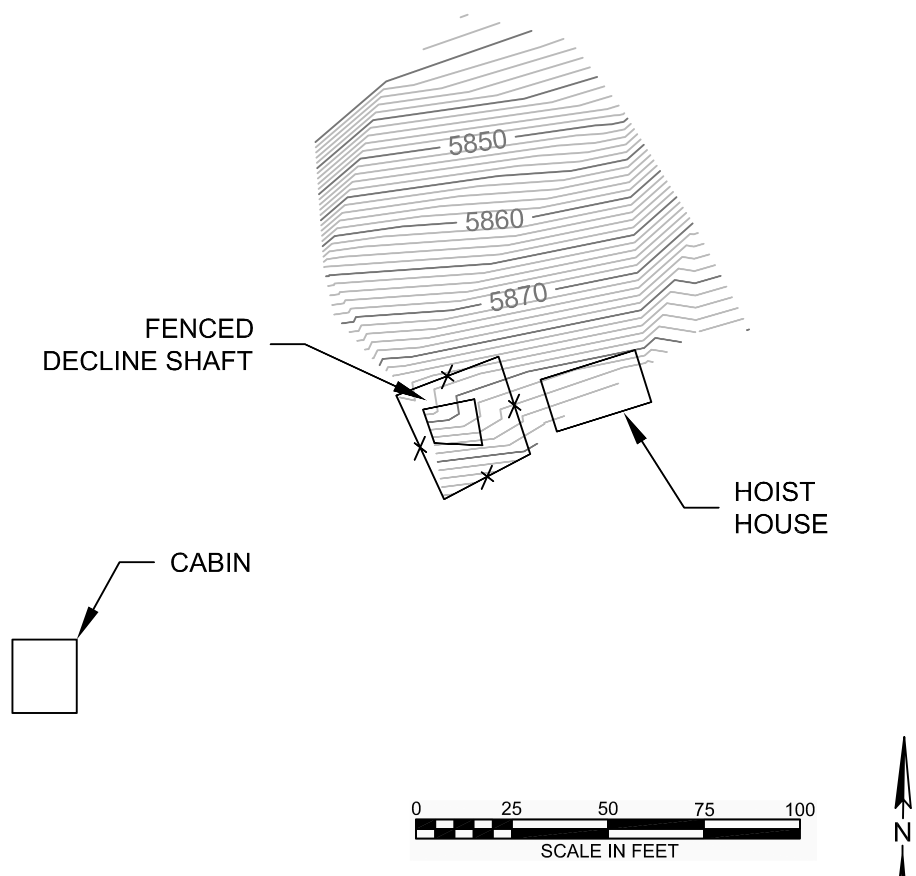






Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	DRUMLUMMON MINE AREA	FIGURE 6-17

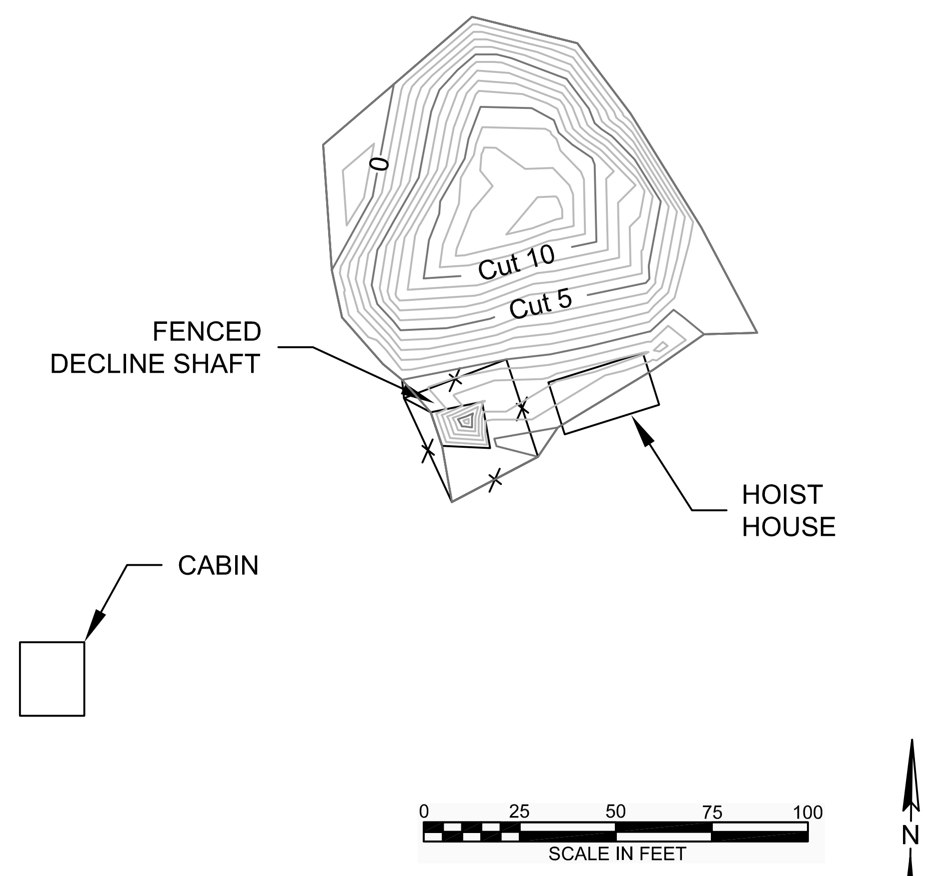
DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 11/2002	JOB NO: A1284	SCALE: AS SHOWN	FILENAME: A1284Dmine.dwg



PROJECTED NATIVE SURFACE

Prismoidal Volume Results

Original Surface Model:	WR1
Final Surface Model:	WR1bot
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	1462 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	1462 cu yd
Raw Fill Volume:	67 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	67 cu yd



WASTE ROCK DEPTH CONTOURS

Olympus Technical Services, Inc.	DRAWN: KSR CHECKED: CRS DATE: 1/2003	SCALE: AS SHOWN JOB NO: A1284 FILE: A1284Dmine.dwg	WASTE ROCK PILE WR1 EXISTING TOPOGRAPHY, PROJECTED NATIVE SURFACE AND DEPTH CONTOURS

FIGURE 6-18

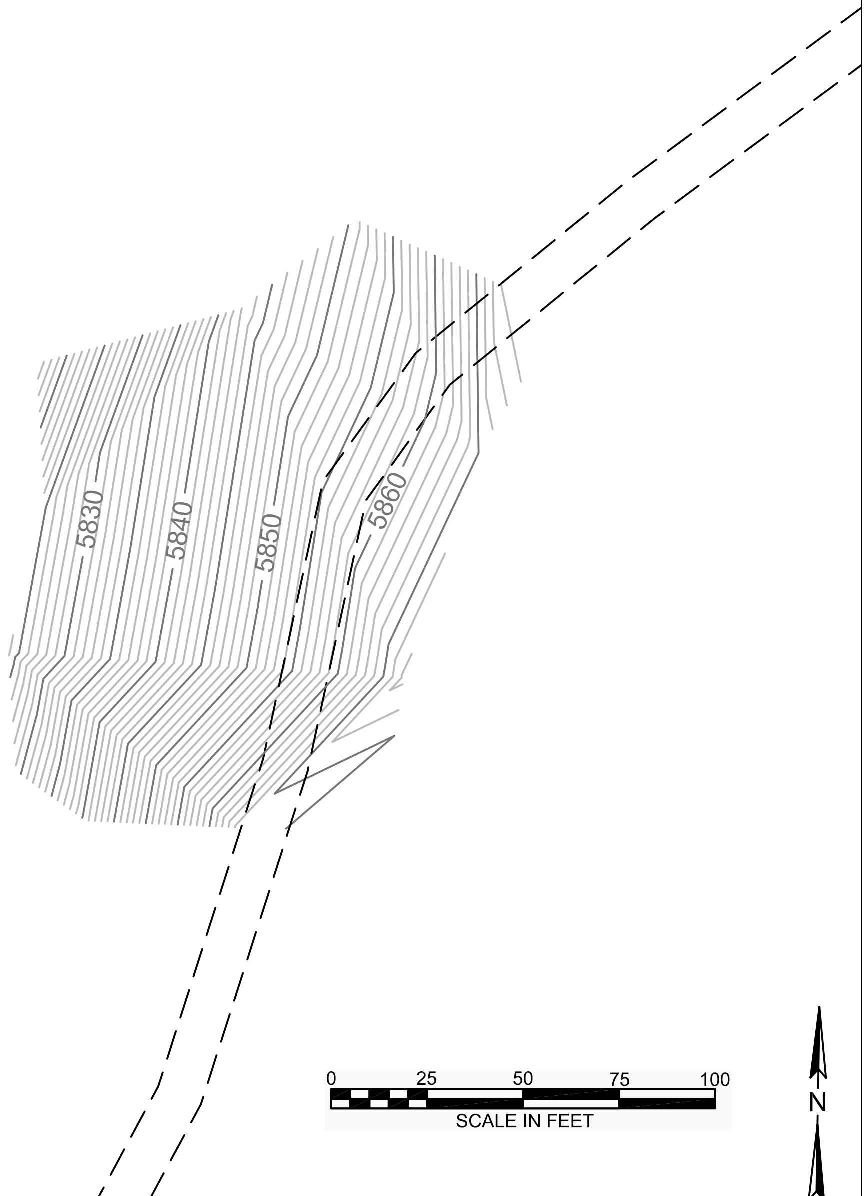
Waste rock pile WR2 is located near the west end of the Drumlummon mine area (Figure 6-17). A detailed topographic survey of WR2 was completed and used to estimate the waste rock volume. The volume was calculated using Eagle Point surface models of the waste rock pile surface and the projected native surface below the pile. No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The projected native surface and depth contours are shown in Figure 6-19. The estimated volume of WR2 is 2,960 cubic yards. The plan area of WR2 is 0.34 acres and the average waste rock depth is 5.37 feet.

Waste rock pile WR3 is located at the east end of the Drumlummon mill (Figure 6-20). The pile appears to consist of an older portion in the lower half and a newer portion that was end dumped over the lower half. A detailed topographic survey of WR3 was completed and used to estimate the waste rock volume. The volume was calculated using Eagle Point surface models of the waste rock pile surface and the projected native surface below the pile. No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The projected native surface and depth contours are shown in Figure 6-21.The estimated volume of WR3 is 3,500 cubic yards. The plan area of WR3 is 0.45 acres and the average waste rock depth is 4.84 feet.

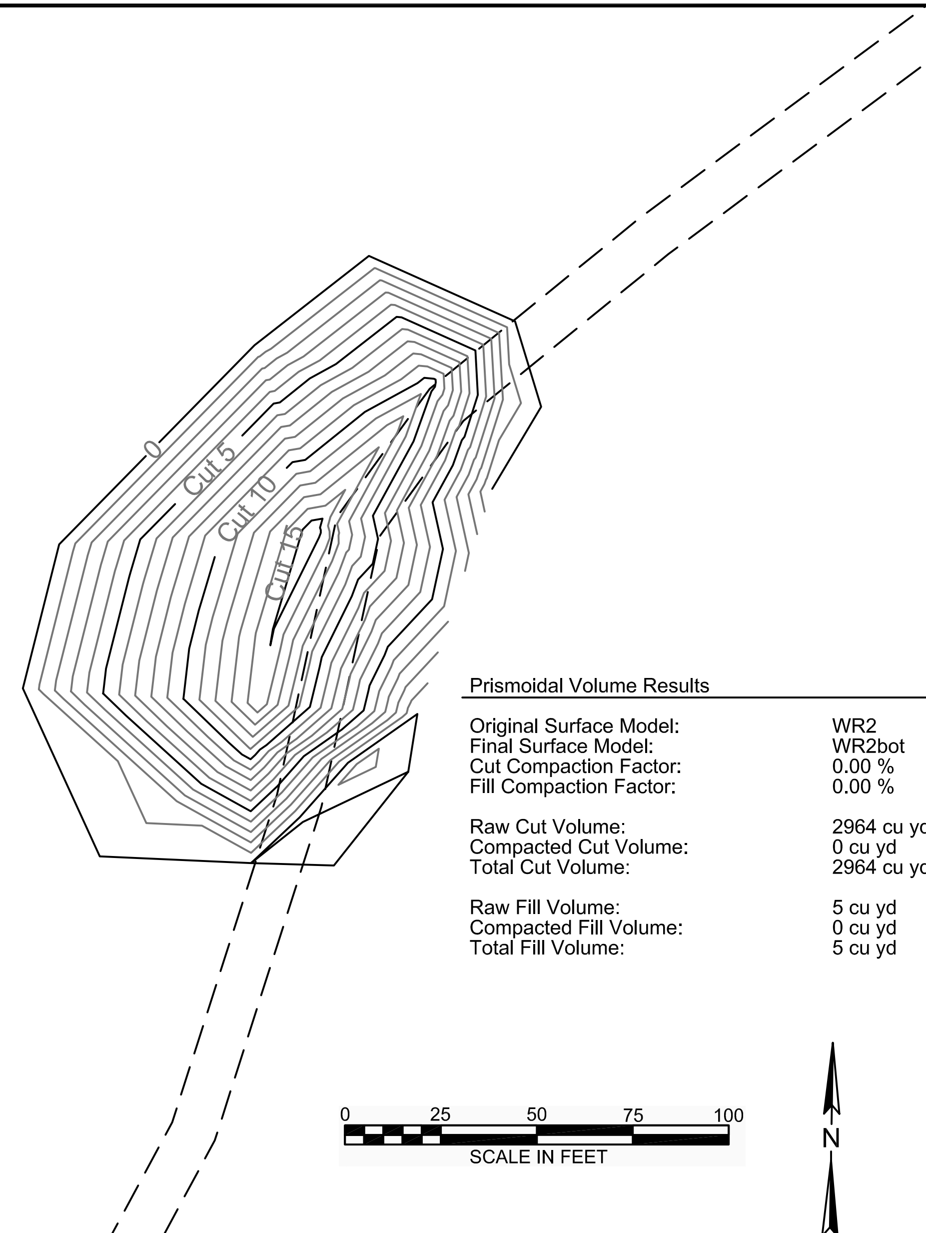
Waste rock pile WR4 is located at the west end of the Drumlummon mill and extends northward to Marysville Road (Figure 6-20). The waste rock appears to have originated from a main haulage adit at the south end of the pile. Rail tracks are present on the top of WR4 and extend from the adit to the north end of WR4 with a spur that runs northeast toward the mill. The tracks probably extended behind the mill to waste rock pile WR3. A detailed topographic survey of WR4 was completed and used to estimate the waste rock volume. The volume was calculated using Eagle Point surface models of the waste rock pile surface and the projected native surface below the pile. No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the existing elevations below the toe of the pile and from the slopes adjacent to the waste rock pile. The projected native surface and depth contours are shown in Figure 6-21. The estimated volume of WR4 is 110,510 cubic yards. The plan area of WR4 is 2.77 acres and the average waste rock depth is 24.75 feet. The maximum waste rock depth is approximately 74 feet.

6.4.2 Waste Rock Pile Geology

The Drumlummon waste rock piles are generally steep angle of repose piles, the larger of which were likely generated from side dumping rail cars used for underground mine haulage. The Drumlummon waste rock piles gradation consists of a heterogeneous mixture of sand to ≥ 12-inch diameter rock. Rock is the predominant component of the waste rock piles and consists of black to greenish, fine-grained hornfels with various degrees of propylitic alteration, granodiorite to quartz diorite, and a trace of limestone to dolomite. Lesser white quartz and/or carbonate vein and brecciated hornfels material with some sulfide may be present. Iron oxide occurring as orange brown to red brown coloration is variable at WR4 and WR3, but generally not abundant in the waste rock piles. Waste rock piles WR1 and WR2 did not show any noteworthy evidence of FeOx alteration. It is most noticeable in the lower section of the toe area of waste rock pile



PROJECTED NATIVE SURFACE



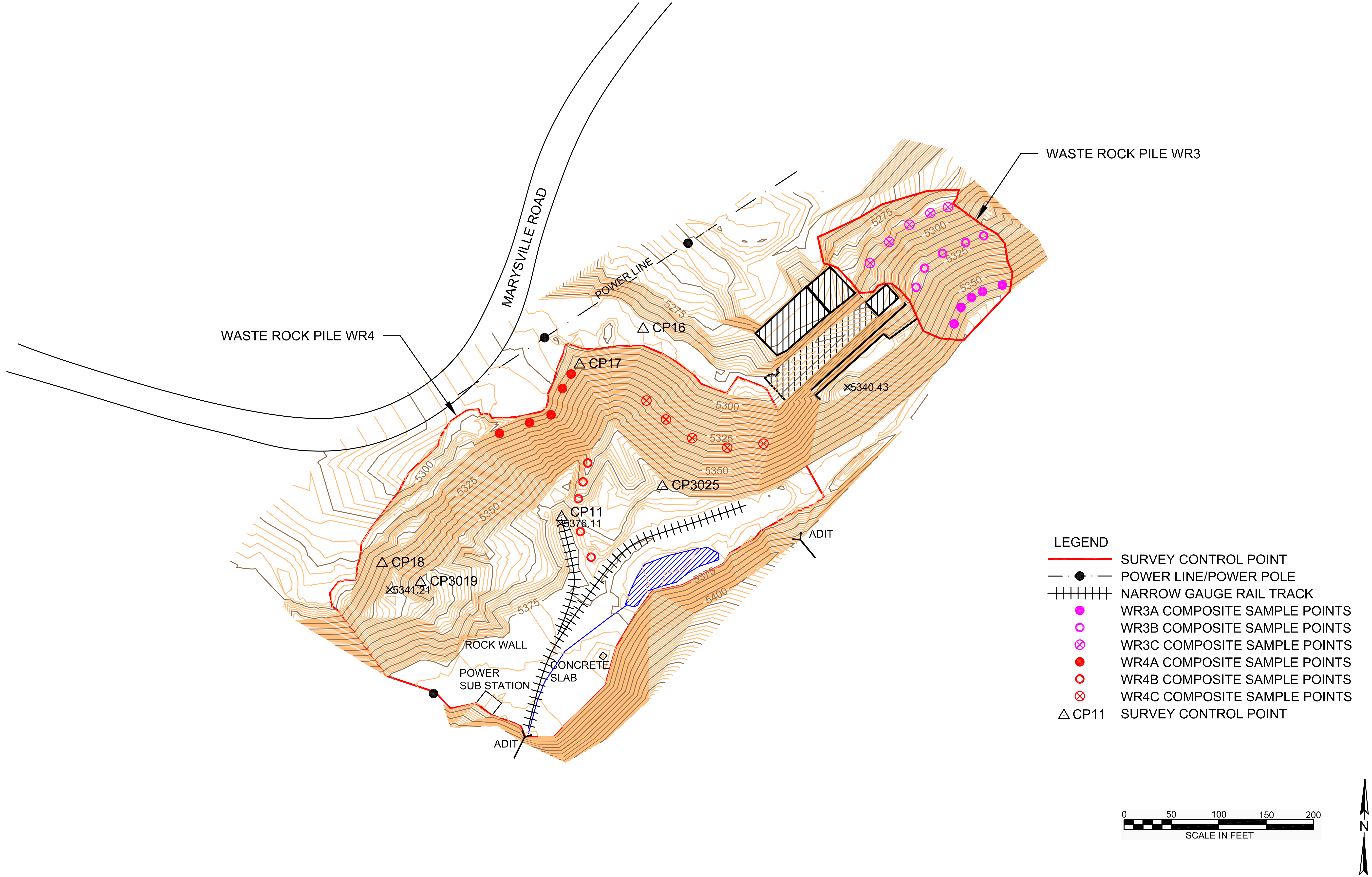
Prismoidal Volume Results

Original Surface Model:	WR2
Final Surface Model:	WR2bot
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	2964 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	2964 cu yd
Raw Fill Volume:	5 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	5 cu yd

WASTE ROCK DEPTH CONTOURS

Olympus Technical Services, Inc.

DRAWN: KSR	SCALE: AS SHOWN	WASTE ROCK PILE WR2 EXISTING TOPOGRAPHY, PROJECTED NATIVE SURFACE AND DEPTH CONTOURS
CHECKED: CRS	JOB NO: A1284	FIGURE 6-19
DATE: 1/2003	FILE: A1284Dmine.dwg	



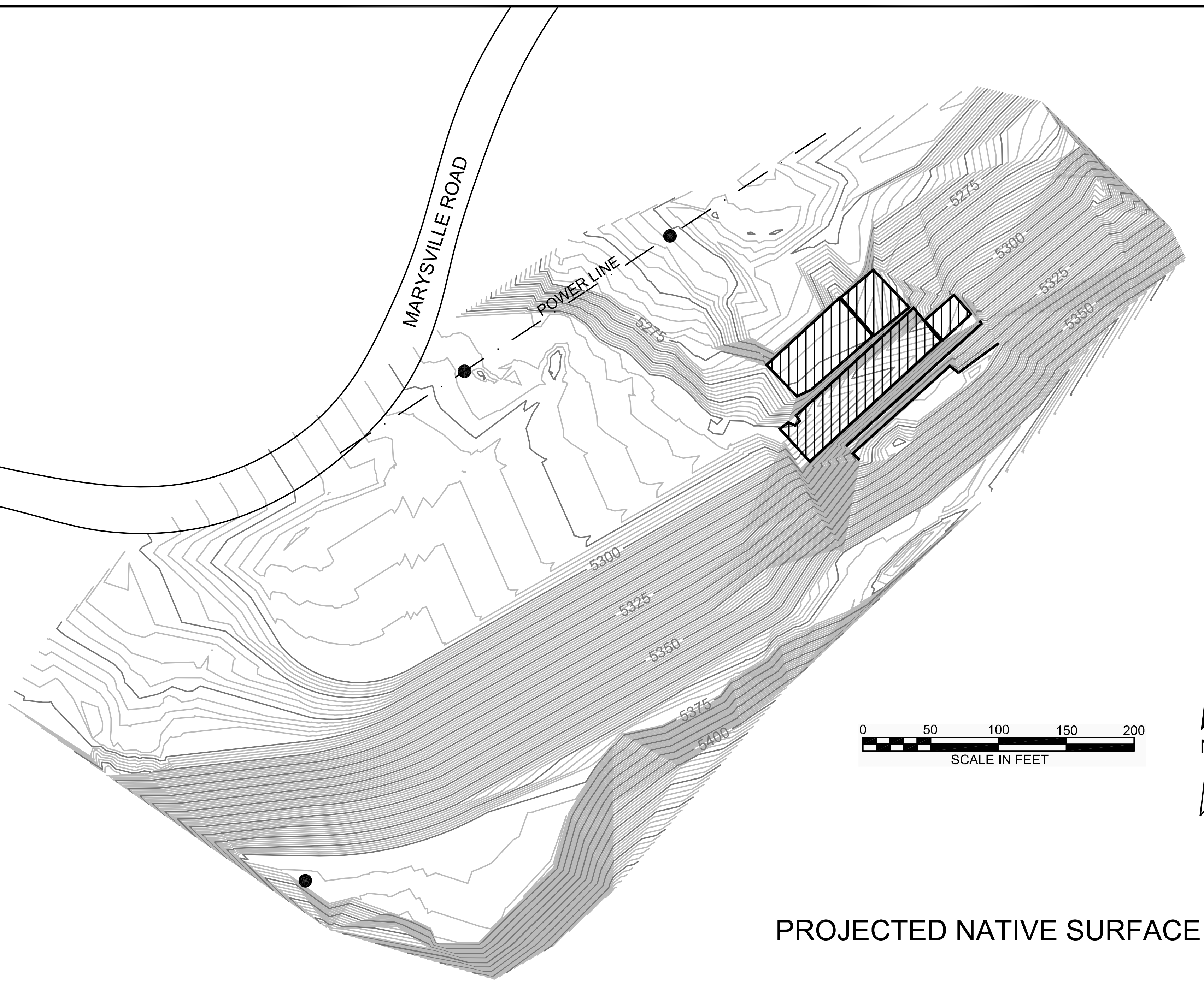
NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: CRS
				APPROVED:	DATE: 10/2002	JOB NO: A1284
				SCALE: AS SHOWN	FILENAME: A1284Dmill.dwg	

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

DRUMLUMMON MILLSITE AREA
WASTE ROCK PILES WR3 AND WR4
EXISTING TOPOGRAPHY

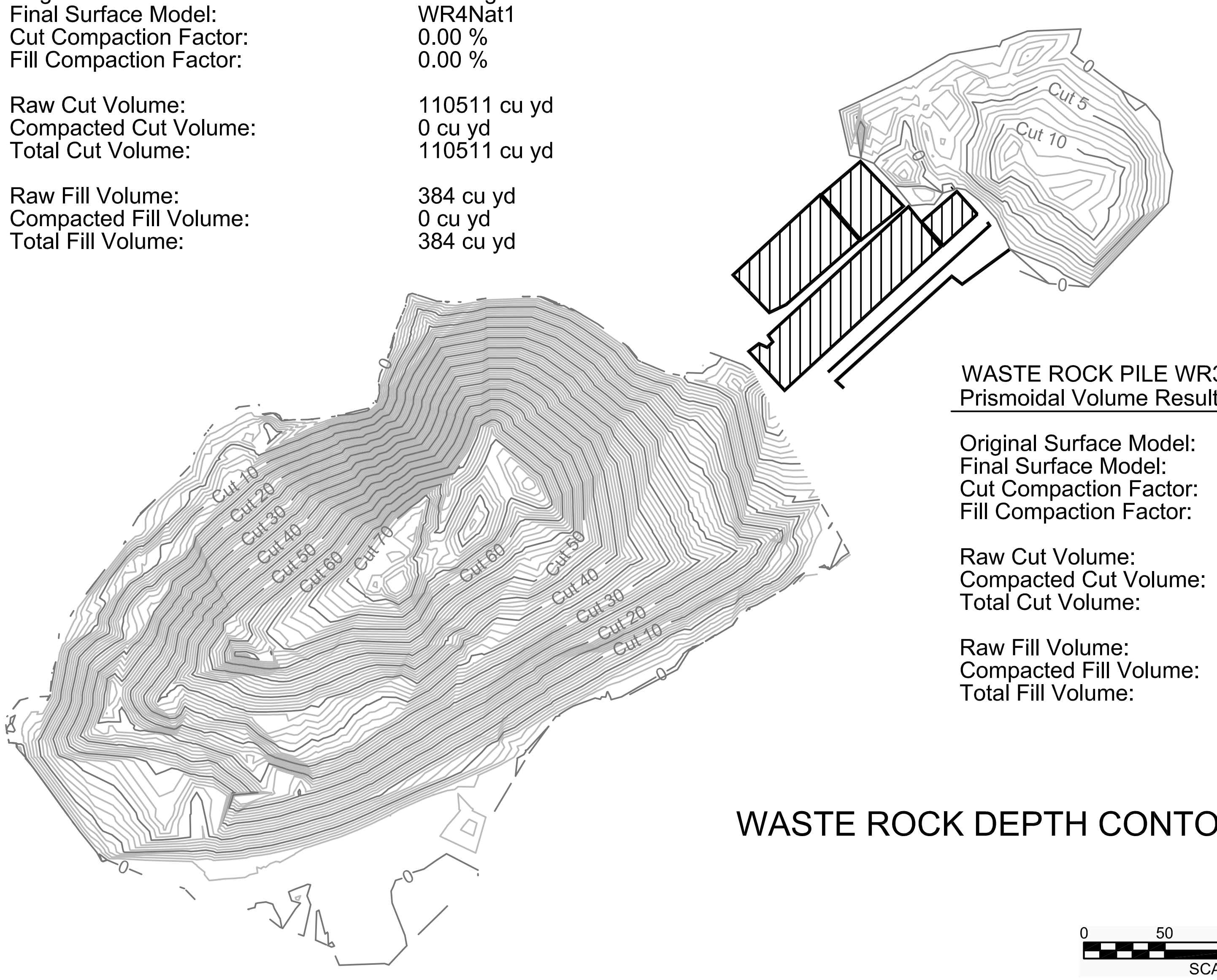
FIGURE
6-20



PROJECTED NATIVE SURFACE

WASTE ROCK PILE WR4
Prismoidal Volume Results

Original Surface Model:	Existing
Final Surface Model:	WR4Nat1
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	110511 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	110511 cu yd
Raw Fill Volume:	384 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	384 cu yd



WASTE ROCK PILE WR3
Prismoidal Volume Results

Original Surface Model:	Existing
Final Surface Model:	WR3nat
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	3500 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	3500 cu yd
Raw Fill Volume:	42 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	42 cu yd

WASTE ROCK DEPTH CONTOURS

0 50 100 150 200
SCALE IN FEET
N

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	WASTE ROCK PILES WR3 AND WR4 PROJECTED NATIVE SURFACE AND DEPTH CONTOURS	FIGURE 6-21

DESIGN:	DRAWN: KSR	CHECKED: KSR	APPROVED:	DATE: 10/2002	JOB NO: A1284	SCALE: AS SHOWN	FILENAME: A1284Dmill.dwg

WR4. This pile has recent evidence of excavation, suggesting that it is being used as a borrow source. Excavation has also exposed thin layers (generally ≤ 6-inch thick) of charcoal in WR4. The source of this charcoal was probably furnace charcoal generated during mill operations.

The main haulage level adit, located near the south end of the WR4 waste rock pile is discharging water. The water drains to a small pond located on top of the WR4 (Figure 6-20) where it evaporates and infiltrates into the pile. The flow of water at the time of this site characterization was low, probably less than 1 gallon per minute (gpm). Discharge flow estimates of up to 45 gpm have been made for this adit during earlier site characterization studies. No evidence for ponding of water was observed on the other waste rock piles.

6.4.3 Waste Rock Pile Metals/pH Chemistry Results

Representative samples were collected from shovel pits excavated into the waste rock piles. Individual samples were collected based on similar geologic characteristics. Nine waste rock pile samples and two representative composite waste rock samples were collected from the Drumlummon millsite and mine areas for XRF screening. The XRF results are contained in Appendix C. The Drumlummon waste rock XRF results indicate that the waste rock generally contains undetectable to low concentrations for the principal elements of interest, i.e. Ag, As, Cd, Cu, Hg, Mn, Pb, and Zn.

Laboratory analytical data for the two composite samples collected from the Drumlummon waste rock piles are summarized in Table 6-6. The waste rock pH is alkaline ranging from 8.1 to 8.6 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for the parameters analyzed are as follows:

Ag 3.8 mg/Kg (1.5x), As 17.0 mg/Kg (0.8x), Ba 79.5 mg/Kg (0.6x), Cr 12.0 mg/Kg (1.0x), Cu 52.5 mg/Kg (1.5x), Fe 13,550 mg/Kg (1.0x), Pb 39.5 mg/Kg (3.5x), Hg 1.3 mg/Kg (2.6x), Mn 429.0 mg/Kg (0.9x), Ni 8.5 mg/Kg (0.9x), Sb 4.3 mg/Kg (0.9x), and Zn 66.0 mg/Kg (1.0x). Cadmium was not detected above the method detection limit. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the low concentrations determined by XRF screening. The data suggest that most of the waste rock was probably derived from non-mineralized country rock which was removed from the underground mine during mine development. The low concentration of Hg detected in one of the composite samples is most likely natural occurring and is related to the precious metal vein system that constitutes the orebody in the mine.

6.4.4 Waste Rock Pile Acid/Base Accounting Results

The waste rock located in the Drumlummon millsite and mine areas generally do not show much field evidence of acid rock drainage (ARD) problems. Although there is some iron oxidation in the waste rock, it is relatively minor compared to the volume of exposed rock. The waste rock piles are poorly vegetated and this is most likely due to the coarse gradation present in the piles. As discussed earlier, the waste rock paste pH data indicate that the waste rock is not acidic.

Table 6-6. Laboratory Chemistry Results for Waste Rock

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Pb (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
25-024-WR5	8.6	<5	7	52	<1	14	53	15000	12	<1	442	8	<5	46
25-024-WR6	8.1	5	27	107	<1	10	52	12100	67	2	416	9	6	86
Maximum	8.6	5	27	107		14	53	15000	67	2	442	9	6	86
Minimum	8.1	<5	7	52		10	52	12100	12	<1	416	8	<5	46
Mean	8.4	3.8	17.0	79.5		12.0	52.5	13550.0	39.5	1.3	429.0	8.5	4.3	66.0
n	2	2	2	2		2	2	2	2	2	2	2	2	2

LEGEND

25-024-WR5 is a composite of 25-SCD-WR1, WR2A & WR2B
25-024-WR6 is a composite of 25-SCD-WR3A, WR3B, WR3C, WR4A, WR4B & WR4C

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

Composite samples of waste rock from the Drumlummon millsite and mine were evaluated for static ABA methods to evaluate the acid generating potential and inherent neutralization capability of the waste rock. Two composite samples were collected for ABA analyses at Energy Laboratories, Inc. The laboratory analytical results are contained in Appendix C and are summarized in Table 6-4. The ABA data indicate that the total sulfur concentrations in the waste rock are low ranging from 0.08% to 0.10%. Low total sulfur concentrations limit the potential for ARD development. Both of the composite samples show significant positive net ABA ranging from 75 to 158, indicating that the waste rock is probably not acid generating. The inherent neutralization potential of the waste rock is further corroborated by the XRF results for calcium that showed concentrations ranging from 1.4% to 4.8%. These data indicate that calcium carbonate ($CaCO_3$) concentrations may be as high as 12.0% in the waste rock.

6.4.5 Waste Rock Pile TCLP Results

Splits of the two waste rock composite samples were collected for metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) TCLP analysis at Energy Laboratories, Inc. in Billings, Montana. The waste rock TCLP laboratory analytical results are contained in Appendix C and are summarized in Table 6-5. The results indicate that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification.

7.0 GROUNDWATER CHARACTERIZATION

Groundwater in the Silver Creek Drainage area occurs in both bedrock and alluvial aquifers. As described earlier, groundwater assessments have been conducted in the Marysville town area by examining water wells. Few data exist downstream from Marysville within the mine/mill waste impacted area of the Silver Creek drainage.

7.1 LOCATION OF WELLS NEAR THE SILVER CREEK DRAINAGE PROJECT

In the Silver Creek drainage, the deeper groundwater most likely occurs in a structurally complex bedrock and the shallow groundwater is located in the alluvium of the Silver Creek drainage basin. Characterization of the bedrock aquifer would be very costly and is not deemed necessary at this time. The tailings piles are the waste sources which appear to have the greatest potential for impacting groundwater. With the tailings piles located in the immediate drainage area of Silver Creek, impacts to groundwater would likely be observed in the shallow alluvial aquifer. The Montana Bureau of Mines and Geology well database was searched for wells located within the immediate project area by Section, Township and Range. The results of the search are summarized in Table 7-1.

The well search yielded records for three wells in Section 33, Township 12 North, Range 5 West, which is in the vicinity of the Goldsil tailings. Two of the wells are listed under Silver Creek Mining, and they were drilled in August 1974 for industrial use. The total depths of these wells are reported as 65 and 76 feet, with static water levels of 1 and 2 feet and yields of 40 and 45 gallons per minute. The third well is listed under Earl Fred and the location is reported in the SW ¼, SE ¼ of Section 33. This location would be slightly south and west of the Goldsil tailings and in the vicinity of the abandoned Argo Millsite. This well was drilled in June 1973 for domestic use and has a reported total depth of 47 feet, a static water level of 18 feet and a yield of 25 gallons per minute.

TABLE 7-1 SUMMARY OF WELLS IN THE SILVER CREEK AREA

	No. of	Total Depth (feet)				Static Water Level (feet)			
Section	Wells	Average	Median	Min.	Max.	Average	Median	Min.	Max.
Township 12 North, Range 6 West									
35	8	115	80	24	400	32	25	15	75
36	42	80	60	12	282	23	15	5	63
Township 12 North, Range 5 West									
31	0	--	--	--	--	--	--	--	--
32	0	--	--	--	--	--	--	--	--
33	3	63	65	47	76	7	2	1	18
34	3	400	450	300	450	117	114	95	143
Township 11 North, Range 5 West									
1	12	120	105	58	228	48	50	2	88
2	0	--	--	--	--	--	--	--	--
3	1	401	--	401	401	150	--	150	150
5	0	--	--	--	--	--	--	--	--
Township 11 North, Range 4 West									
6	28	174	135	43	437	52	60	16	100
7	11	151	140	82	240	71	60	16	170
8	6	70	35	18	132	18	10	8	45
16	6	51	20	14	200	17	22	2	38
17	2	29	--	16	42	5	--	4	--
21	10	258	240	40	560	56	60	7	100

The well search also yielded records for three wells in Section 34, Township 12 North, Range 5 West, which is near the downstream end of the Goldsil tailings area. All three of the wells are in the S½ of Section 34, have total depths of 300, 450 and 450 feet and have reported static water levels of 143, 95 and 114 feet, respectively. Two of the wells are listed as domestic use and were drilled in 1995 and 1996. The third well does not have a reported use or date.

Previous reports by Hydrometrics, Inc. (1983) indicate that there are six monitoring wells at the Goldsil site in the vicinity of the lined pond west of the former mill building. A map prepared by Hydrometrics that shows the location of the monitoring wells was found in a review of files at the DEQ Enforcement Division. The PVC casings for five of these monitoring wells were located and all the wells were uncapped except one. In addition, there is a covered, 2 feet diameter steel drum which appears to be plumbed into the five monitoring wells as a sampling sump. Shallow groundwater collected in the monitoring wells appears to be gravity fed via PVC piping to the sump.

7.2 SUMMARY OF MONITORING WELL DRILLINGS ACTIVITIES

As part of an investigation for a potential mine/mill repository site, an assessment of the depth and chemistry of shallow groundwater contained in the alluvial aquifer was undertaken in the Goldsil tailings area. Monitoring well drilling for MW1, MW2, MW3 and MW4 was initiated on November 21, 2002 and completed on November 22, 2002 by O'Keefe Drilling Company, Butte, Montana. The wells were drilled using an air rotary drilling rig. The monitoring wells were completed in an area where preliminary engineering estimates indicate the potential for a mine/mill waste repository that could accommodate the bulk of the waste identified to date. The potential repository site area and monitoring well locations are shown in Figure 7-1. Completion data are presented in the well logs contained in Appendix F. The following summarizes the monitor well drilling and development activities for each well.

7.2.1 Monitoring Well MW1

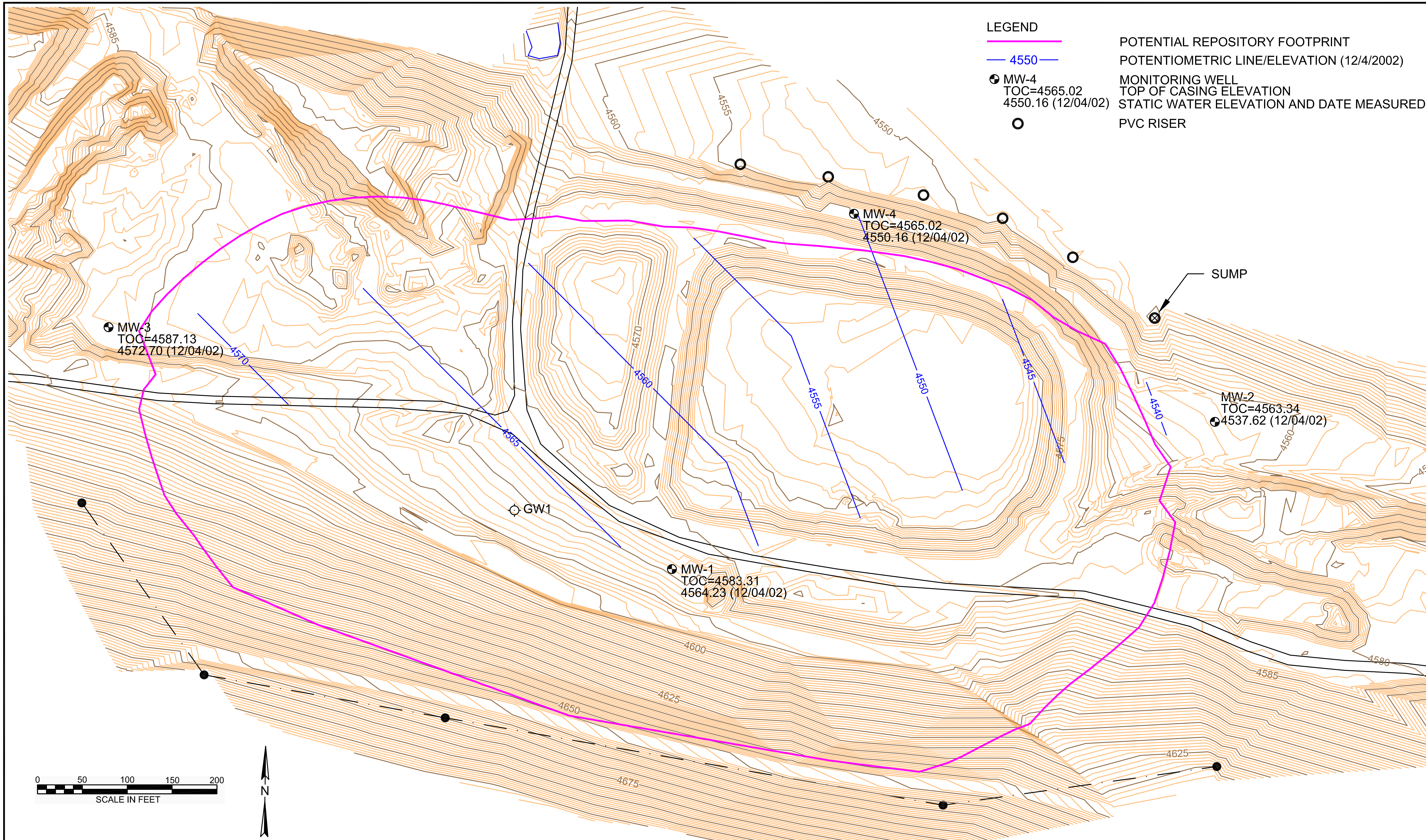
The well was drilled on November 22, 2002 to total depth of 25.0 feet. The 6-inch diameter, vertical drill hole contained probable colluvium consisting of light tan to tan, unconsolidated sand and gravel with rock to a depth of 14.6 feet (last 4 feet contained very minor rock). From 14.6 to 23.0 feet the drill intersected brown to tan sandy gravel with slight moisture. The drill steel was pulled out of the hole to examine the steel and bit for moisture which was not observed. The drill bit was lowered into hole and air pressure was used to blow the hole at which time water was observed. The hole was advanced to a total depth of 25.0 feet and the monitoring well was completed at 1300 hours. Upon returning to develop the monitoring well at 1445 hours after completing monitoring well MW3, the water level probe would only advance to 16.3 feet. After confirming with the drillers that the hole was block off, it was decided to attempt to pull the well casing and drill the well out to reconstruct the monitoring well. The well was pulled and it was noted that the screen looked like a slinky toy with major flexures at four different points on the screen. Although the screen was not cracked, the flexure was significant enough to bridge it off prohibiting access to the bottom of the hole. The hole was re-entered using the down-hole hammer where increased air pressure was available for cleaning the hole. The monitoring well was then reconstructed. Well construction details are as follows:

0’ to +1.5’	Cemented 6” dia. steel pipe stickup with locking cap (note: steel casing total 5.0’; 3.5’ subsurface)
0.5’ to 13.0’	Bentonite hole plug; 3/8” chips
13.0’ to 25.0’	Colorado Silica Sand, 10-20 mesh filter pack
14.5’ to 24.5’	10’ PVC slotted screen (Schedule 40, 0.020” slotted openings)

The well was developed on November 25 by hand bailing 50 gallons. The static water level was measured below the top of the casing (TOC) at 19.0 feet and 19.08 feet on November 25, 2002 and December 4, 2002, respectively.

7.2.2 Monitoring Well MW2

The well was drilled on November 21, 2002 to a total depth of 42.5 feet. The 6-inch diameter, vertical drill hole contained tan to light gray, colluvium consisting of unconsolidated sand and gravel with rock to a depth of approximately 35 feet. No moisture was observed in the drill cuttings. From 35 to 42.5 feet, oxidized, orange brown (most likely at the contact zone) transitioning rapidly to light tan alluvial sand and rounded, pea-sized, gravel was intersected. The bit was pulled back for inspection and showed evidence of moisture. The hole was left open for a few minutes, then re-entered and water was observed upon blowing the hole with air pressure. Well construction details are as follows:



NO.	REVISION DESCRIPTION	BY	DATE

DESIGN: | DRAWN: KSR | CHECKED: CRS
APPROVED: | DATE: 8/2002 | JOB NO: A1284
SCALE: AS SHOWN | FILENAME: A1284GM.dwg

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL TAILINGS
MONITORING WELL LOCATION MAP
AND POTENTIOMETRIC SURFACE

FIGURE
7-1

0' to +1.5'	Cemented 6" dia. steel pipe stickup with locking cap (note: steel casing total 3.0'; 1.5' subsurface)
1.0' to 25'	Bentonite hole plug; 3/8" chips
25' to 42.5'	Colorado Silica Sand, 10-20 mesh filter pack
27' to 42'	15' PVC slotted screen (Schedule 40, 0.020" slotted openings)

The well was developed on November 21 and 22, 2002 by pumping 125 gallons with an air development pump. The static water level was measured below the TOC at 25.3 feet and 25.72 feet on November 25, 2002 and December 4, 2002, respectively.

7.2.3 Monitoring Well MW3

The well was drilled on November 22, 2002 to a total depth of 20.5 feet. The 6-inch diameter, vertical drill hole contained colluvium consisting of brown to light tan, unconsolidated sand and gravel with rock to a depth of 16.0 feet. From 16 to 20.5 feet orange brown sand plus gravel alluvium was intersected. Slight moisture was observed at approximately 16.0 feet. The drill bit was pulled back and the hole was left standing for a few minutes, then drilling continued to 20.5 feet at which time the hole was stopped due to wet drill cuttings. Well construction details are as follows:

0' to +1.5'	Cemented 6" dia. steel pipe stickup with locking cap (note: steel casing total 3.0'; 1.5' subsurface)
1.0' to 8.0'	Bentonite hole plug; 3/8" chips
8.0' to 20.5'	Colorado Silica Sand, 10-20 mesh filter pack
10.0' to 20.0'	10' PVC slotted screen (Schedule 40, 0.020" slotted openings)

The well was developed on November 25, 2002 by hand bailing 100 gallons. The static water level was measured below the TOC at 14.0 feet and 14.43 feet on November 25, 2002 and December 4, 2002, respectively.

7.2.4 Monitoring Well MW4

The well was drilled on November 21, 2002 and well construction was completed on November 22, 2002 to a total depth of 25.5 feet below ground surface. The 6-inch diameter, vertical drill hole was collared in fill comprising the lower bench of the lined tailings pond. From 0 to 13 feet depth the drill intersected fill materials consisting of sand, gravel and minor rock used to construct the lower bench of the lined tailings pond. From 13 feet to 27 feet, the drill intersected alluvium with abundant fine sand and variable gravel. Very abundant water was intersected and the hole would not stay open upon pulling the drill steel. Casing had to be driven in order to complete the well. The final depth of the well construction was 25.5 feet due to caving. It appeared that the drill intersected an alluvial channel with subsurface flow. The flow of subsurface water could be heard rushing through the drill hole. The combination of cleaning the hole with pressured air (abundant removal of fine sand) and the flowing water in the subsurface channel caused severe problems in well completion. After setting 15 feet of screen in the bottom of the hole, it required 28 bags of filter pack sand to just bring the filter pack up to 14.5 feet from the top of casing. The fine sand was being flushed away from the drill hole annulus by the flowing water. After the last two bags of sand only gained 2.5 inches in the filter pack, it was decided to backfill the remaining footage to 8 feet depth with the coarser-grained drill cuttings. Most of these cuttings were generally well washed because of the high volume of water that flowed into the hole. In order to complete the well, cuttings were placed to 8 feet below the top of the casing which was 2.5 feet above the top of the well screen.

Well construction details are as follows:

0' to 0.5'	Cemented 6" dia. steel flush mount with bolted steel cap and locking PVC pipe cap
0.5' to 8'	Bentonite hole plug; 3/8" chips
8' to 14.5'	Drill cuttings backfilled
14.5' to 25.5'	Colorado Silica Sand, 10-20 mesh filter pack
10.0' to 25.0'	15' PVC slotted screen (Schedule 40, 0.020" slotted openings)

The well was developed on November 22, 2002 by pumping and hand bailing 80 gallons. The static water level was measured below the TOC at 15.0 feet and 14.86 feet on November 25, 2002 and December 4, 2002, respectively.

The monitoring wells were surveyed on November 22, 2002. Table 7-2 summarizes the monitoring well survey and static water level measurements. A potentiometric map of the groundwater surface based on the December 4, 2002 static water level measurements is presented in Figure 7-1. The shallow groundwater flow direction is North 68° East at a gradient of 0.043 feet per foot. In this area, the shallow groundwater flow direction generally parallels the flow of Silver Creek.

7.3 SUMMARY OF GROUNDWATER SAMPLING RESULTS

Water samples were collected from the four monitoring wells on December 4, 2002 after purging at least three well volumes and achieving stable field parameters for pH, temperature and specific conductivity. In addition, a shallow groundwater sample was collected on June 12, 2002 from a 2 feet diameter, covered steel drum located near the northeastern corner of the lined tailings pond. This steel drum acts as collection point for 5 shallow PVC monitoring wells or piezometers located immediately north of and along the toe of the lined tailings pond. Water was overflowing the sump and discharging to the Silver Creek floodplain.

Water quality samples (MW1, MW2, MW3 and MW4) and quality control samples (MW5 and MW6) collected from the shallow monitoring wells were sent to Energy Laboratories, Inc. in Billings, MT where they were analyzed for total recoverable and dissolved concentrations for the following analytes: Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb and Zn. In addition to the metal/metalloid analyses, pH, total cyanide, total dissolved solids (TDS), sulfate, nitrate + nitrite as N, and chloride analyses were done. The water quality sample from the sump area (25-365-GW1) was collected and analyzed by Energy Laboratories, Inc. during the Phase I site characterization and was run for the same analyte suite (excluding dissolved metal/metalloid concentrations) as the monitoring well samples. The laboratory analytical data including quality control results and chain-of-custody are presented in Appendix F. The analytical results are summarized in Table 7-3. It is readily apparent from the shallow aquifer sampling results that elevated water quality concentrations are almost exclusively associated with the total recoverable metal verses the dissolved metal concentrations. The only exception is the

Table 7-2. Monitoring Well Survey and Static Water Level Measurement Results

WELL ID	Northing	Easting	Top of Casing (TOC) Elev. (Ft.)		Static Water Level Below TOC (Ft.)	Ground Water Elev. (Ft.)	Static Water Level Below TOC (Ft.)	Ground Water Elev. (Ft.)
				Date	11/25/2002	11/25/2002	12/4/2002	12/4/2002
MW-1	49824.68	50402.62	4583.310		19.0	4564.31	19.08	4564.23
MW-2	49988.81	51007.59	4563.336		25.3	4538.04	25.72	4537.62
MW-3	50094.25	49774.79	4587.126		14.0	4573.13	14.43	4572.70
MW-4	50220.68	50605.45	4565.016		15.0	4550.02	14.86	4550.16

TABLE 7-3. Laboratory Chemistry Results For Groundwater

Total Recoverable Metals

Sample ID	Ag (ug/L)	As (ug/L)	Ba (ug/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	Mn (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Zn (ug/L)
MW-1	<5	33	<100	<1	<10	<10	1930	<0.1	60	<10	10	<5	20
MW-2	<5	107	100	<1	<10	10	5350	0.2	180	<10	7	<5	50
MW-3	12	65	300	<1	<10	70	8850	1.5	1380	<10	14	<5	50
MW-4	66	5	100	<1	<10	40	2470	11	100	<10	3	<5	10
MW-5	<5	<3	<100	<1	<10	<10	<30	<1	<10	<10	<2	<5	<10
MW-6	<5	109	100	<1	<10	10	5110	0.2	180	<10	7	<5	50
25-365-GW-1	350	22	200	2	<10	190	4140	7	2230	10	<10	<50	20
Federal MCL	-	50	2000	5	-	1300	300	2	50	100	15	6	5000

Dissolved Metals

Sample ID	Ag (ug/L)	As (ug/L)	Ba (ug/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)	Mn (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Zn (ug/L)
MW-1	<5	<3	<100	<1	<10	<10	<30	<1	<10	<10	<2	<30	<10
MW-2	<5	<3	<100	<1	<10	<10	<30	<1	<10	<10	<2	<30	<10
MW-3	<5	<3	<100	<1	<10	<10	<30	<1	<10	<10	<2	<30	<10
MW-4	7	<3	<100	<1	<10	<10	<30	2	<10	<10	<2	<30	<10
MW-5	<5	<3	<100	<1	<10	<10	<30	<1	<10	<10	<2	<30	<10
MW-6	<5	<3	<100	<1	<10	<10	<30	<1	<10	<10	<2	<30	10
Montana HHS	35	20	2000	5	-	1300	-	2	-	100	15	6	2100

Ground Water Wet Chemistry Results

Sample ID	pH (SU)	TDS (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Nitrate + Nitrite as N (mg/L)	Cyanide (mg/L)
MW-1	7.6	272	20	3	0.11	<0.005
MW-2	7.7	199	26	<1	0.14	<0.005
MW-3	7.5	580	23	2	0.38	<0.005
MW-4	7.6	220	21	2	0.28	<0.005
MW-5	5.8	<10	16	<1	<0.05	<0.005
MW-6	7.6	221	24	2	0.12	<0.005
25-365-GW-1	6.8	260	24	3	0.63	<0.005
Federal MCL	6.5-8.5	500	250	250	10	0.2

Ground Water Field Measurements

Sample ID	pH (SU)	Temp (°C)	SC (mS)	SWL (Ft. Below TOC)
MW-1	8.1	6.5	0.36	19.08
MW-2	7.7	5.2	0.48	25.72
MW-3	8.1	5.8	0.39	14.43
MW-4	7.7	6.4	0.40	14.86
25-365-GW-1	7.6			

LEGEND

MW-1 12/4/2002 Sample collected from monitoring well MW1 located south of southwest corner of the lined tailings pond immediately south of east-west access road

MW-2 12/4/2002 Sample collected from monitoring well MW2 located to the east of the lined tailings pond and west of the Goldsil Mill site

MW-3 12/4/2002 Sample collected from monitoring well MW3 located in the southwest corner of the Goldsil Tailings open pit mine

MW-4 12/4/2002 Sample collected from monitoring well MW4 located near the center of the lower bench of the lined tailings pond

MW-5 12/4/2002 Field blank sample

MW-6 12/4/2002 Duplicate sample of MW2

25-365-GW-1 6/12/2002 Sample collected from 2 feet diameter, covered steel drum located near the northeastern corner of lined tailings pond; acts as collection point for 5 shallow PVC monitoring wells (piezometers?) located immediately north of and along the toe of the tailings pond

Federal MCL - Federal primary and secondary maximum contaminant level based on total recoverable metal concentration; Drinking Water Standards and Health Advisories, EPA October 1996

Montana HHS - Montana human health standard based on dissolved metal concentration; Circular WQB-7 Montana Numeric Water Quality Standards, January 2002 detection of Ag and Hg (although neither concentration exceeded Montana groundwater standards) in water collected from monitoring well MW-4. This suggests that anomalous concentrations of target analytes are likely related to suspended sediment in the water samples. Based on the elevated iron and manganese concentrations present in all four wells, it is possible that detected total recoverable metals are complexed with one or both of these metals.

Federal safe drinking water act (SDWA) standards for groundwater are based on total recoverable metal concentrations whereas Montana human health standards (HHS) are based on dissolved metal concentrations. The wells and analytes which were equal to or exceeded total recoverable metal concentrations for primary and secondary Federal SDWS included: MW-1 (Fe 1,930 ug/L; Mn 60 ug/L); MW-2 (As 107 ug/L; Fe 5,350 ug/L; Mn 180 ug/L); MW-3 (As 65 ug/L; Fe 8.850 ug/L; Mn 1,380 ug/L; TDS 580 mg/L); MW-4 (Fe 2,470 ug/L; Hg 11 ug/L; Mn 100 ug/L). Other than the MW-4 Hg concentration being equal to the groundwater standard, no Montana HHS were exceeded in the dissolved metal concentrations.

The sump water quality sample (25-365-GW-1) results equaled or exceeded primary Federal SDWA maximum contaminant levels for Ag (350 ug/L), Fe (4,140 ug/L), Hg (7 ug/L), and Mn (2,230 ug/L). The elevated parameters in the sump water are generally consistent with the elevated parameters in the nearby monitoring well MW-4 except the concentrations for Ag, As, Fe, and Mn are significantly higher in the sump water. This may be related to seasonal variation due to the fact that the sump sample was collected during late spring conditions. During this period, the water level is increased in the leaking lined tailings pond because of precipitation and spring runoff events. The chemistry of the Goldsil mill vat tailings, the source of the tailings that were deposited into the lined tailings impoundment, is consistent with the elevated parameters in the sump water. Higher water level in the pond would contribute to higher head and the potential for increased leakage through the damaged liner. The tailings impoundment would thus provide an additional source of contaminant loading into the shallow alluvial aquifer under high flow conditions that may not be as significant during low flow conditions.

8.0 ASSESSMENT OF AIRBORNE PARTICULATE EMISSIONS

The principal waste sources in the Silver Creek Drainage Project area are the mill tailings, placer tailings and waste rock piles. Placer tailings and waste rock pile gradations are typically coarse grained containing abundant rock material. These waste sources thus contain lesser fine sediment that could be a source for airborne particulate emissions. The mill tailings typically are very fine grained to fine grained and consist of silt, sand and clay. The near surface tailings commonly exhibit floury textures which when disturbed create dust emissions. Although the mill tailings are generally moderately well vegetated, they do have areas of exposed tailings with little to no vegetation cover. Laboratory chemistry results for composite tailings indicate that mercury (Hg) and total cyanide would be the principal contaminants of concern for airborne particulate emissions. Table 8-1 summarizes the concentrations of Hg and total cyanide for the different mill tailings areas.

The common base metals Cu, Pb and Zn are present in low concentrations in the mill tailings. The combined base metal concentrations in mill tailings range from 124 mg/Kg to 1257 mg/Kg. Other potential airborne contaminants of concern, including As and Cd, also have limited potential for creating airborne particulate emissions problems because of low concentration. Arsenic and Cd maximum concentrations in the mill tailings are 54 mg/Kg and 4 mg/Kg, respectively.

TABLE 8-1 SUMMARY OF MERCURY AND TOTAL CYANIDE CONCENTRATIONS IN MILL TAILINGS

Tailings Area	Range of Hg (mg/Kg)	Range of Total Cyanide (mg/Kg)
Goldsil tailings	18 to 96	<0.5 to 21.1
Drumlummon tailings	<1 to 1	<0.5
Drumlummon millsite tailings	1 to 9	<0.2 to 24.8
Upper Pond Area tailings	32 to 140	0.5 to 1
Middle Pond Area tailings	7 to 26	4.1 to 23.9
Lower Pond Area tailings	27 to 37	2.0 to 5.0

The mill tailings areas which are the most accessible include the Goldsil tailings, the Upper Pond Area and the Lower Pond Area. Secondary roads, accessible from the Marysville Road through unlocked gates, provide easy access to these areas. The other tailings areas are not as readily accessible for they have limited road access and are generally moderately to well vegetated.

9.0 ASSESSMENT OF PHYSICAL HAZARDS

The principal physical hazards in the Silver Creek Drainage Project are associated with the Drumlummon mine and millsite areas. The mill tailings areas have few physical hazards. The following sections summarize the physical hazards identified in the project area.

9.1 DRUMLUMMON MINE AREA

Although numerous adits and shafts were constructed in the Drumlummon mine area, most do not pose significant physical hazards for they have been secured via metal grates or natural collapse. The shafts located near WR2 and at the road intersection northeast of WR2 are both grated over. The only shaft areas identified that pose a physical hazard are an open decline and a partially collapsed shaft. The open decline shaft near the hoist house area north of WR1 is only secured by a barbed wire fence that surrounds it. The shaft appears to be open to the underground workings. The partially collapsed shaft north of the largest open cut pit is fenced but the fact that it is only partially collapsed, does not limit a vertical fall into the underground workings. The adits identified in the mine area do appear to pose a threat because the portal areas are collapsed enough to safeguard them from any access. The most significant physical hazard in the mine area is a series of large open cut pits with very steep highwalls on the upslope side. The upslope area is heavily forested and no fencing and only limited signs are present to warn of the highwall hazard. These highwalls also pose rock fall hazards for persons entering the pit areas.

9.2 DRUMLUMMON MILLSITE AREA

The Drumlummon millsite area contains two large waste rock piles that are essentially steep, scree slopes with no vegetation. These waste rock piles would only constitute a physical hazard to someone who may try to traverse the steep face. The main haulage level adit portal for the Drumlummon underground mine occurs near the south end of waste rock pile WR4. This adit has a door which no longer limits access to the haulage level mine tunnel. The door has been vandalized in that the lock is gone and the hinges have been pried open. The only other physical hazard present is a partially collapsed adit that is still accessible directly south of the Drumlummon mill foundation. The portal has an opening 3 feet high by 5 feet wide.

9.3 MILL TAILINGS AREAS

Few physical hazards are present in the mill tailings areas. The Argo millsite that reportedly was used for reprocessing of mill tailings via cyanide vat leaching contains only ore storage bins and wooden debris. No vat leach tanks are left at the site. The ore storage bins are still standing and do not appear to pose a significant threat of collapse. The wood debris piles may contain rusty nails.

The bone yard located to the southeast of the lined tailings pond area contains cyanide drums which appear to be empty, but may contain residual chemical. The boneyard also contains abundant metal debris which does not appear to constitute a significant physical hazard.

The open pit mine, approximately 600 feet west of the lined tailings pond, in the main Goldsil tailings contains some near vertical cut walls that are 25 feet high. These highwalls are physical hazards in that they pose a fall hazard and collapse hazard.

10.0 SUMMARY OF CONTAMINANT EXPOSURE PATHWAYS

Based on the detailed site characterization results, a preliminary evaluation can be made on exposure pathways. The subject of contaminant exposure and risk assessment will be addressed in the Expanded Engineering Evaluation/Cost Analysis report for the Silver Creek Drainage project which will be completed at a later date. The four exposure pathways, i.e., direct contact, surface water, groundwater, and air, were evaluated to assess the contribution of each route to the overall site human health and environmental threat.

10.1 DIRECT CONTACT

Direct contact with mill tailings sediment presents one of the highest exposure pathways for human and ecological receptors at the site. Although the tailings are generally moderately well vegetated, significant areas of exposed or shallow depth tailings containing elevated mercury and total cyanide are present. Although cyanide generally breaks down to non-toxic forms when exposed to sunlight or oxidation, shallow depth mill tailings sample composites do show elevated total cyanide concentrations. Exposed mill tailings increase the potential for off-site migration of contaminants, especially mercury, and the possibility for inhalation or ingestion of mercury by both human and wildlife receptor populations. Placer tailings and mine waste rock do contain some mercury, but due to the overall coarse gradation of these sources, the potential for direct contact and impact from inhalation or ingestion are lessened.

10.2 SURFACE WATER

Mill tailings are deposited in the Silver Creek drainage basin. In some areas, the tailings (Goldsil tailings) are located in the floodplain, whereas in others, the stream flows through the tailings pile (Drumlummon tailings). Although no surface water sampling was completed during this site characterization, much work has been done in the past by other workers (Section

2.5.4). With the exception of the former Goldsil mill process pond operations which proved to have process water leakage problems, the data generally indicate that surface water quality is not a serious problem in the drainage basin. The reason for this is most likely the non-acid generating nature of the mine/mill waste sources present. Surface water quality impacts are typically more severe when waste sources produce acid rock drainage.

The main impacts to surface water and its substrate appear to be sedimentation from mill tailings piles during stormwater and/or snowmelt runoff events. Mill tailings erosion is evidenced by past dam breach problems at the Drumlummon tailings and the presence of significant erosion rills and subsurface piping which discharges surface water and tailings sediment in the Goldsil tailings area. Other identified mill tailings areas are generally isolated from Silver Creek and its immediate floodplain by berms and/or diversions and thus do not appear to be directly contributing mill tailings sediment to the stream and its floodplain. Erosion of mill tailings is a problem for surface water quality because of turbidity and metal loading into the stream bed, especially mercury. Placer tailings piles are also located within and adjacent to Silver Creek. Sampling results of the placer tailings piles indicate that these tailings can also be a source of mercury if they are eroded into the stream.

Historical references to past operating practices at the Drumlummon mill indicate that there may have been as much as 10 tons of mercury discharged to Silver Creek during the first year of operations (Koerth, 2001). Releases of mercury in the early years from placer and mill operations have undoubtedly also contributed to elevated mercury in the stream bed load.

10.3 GROUNDWATER

Groundwater in the drainage basin occurs at depth in fractured or solutioned carbonate bedrock and in the shallow alluvium of Silver Creek and its floodplain. As part of a potential repository site investigation, groundwater was evaluated in the shallow aquifer (Section 7.0). Groundwater chemistry results from four monitoring wells indicate that Montana groundwater quality standards that are based on the dissolved metal fraction were not exceeded. Federal MCLs which are based on the total recoverable metal analysis were exceeded for As, Fe, Mn, Hg and TDS. This suggests that elevated metal concentrations are likely related to suspended sediment in the groundwater samples. Based on the elevated iron and manganese concentrations present in all four wells, it is possible that detected total recoverable metals are complexed with one or both of these metals. These data suggest that mill tailings sediment may also be a source for suspended sediment in the shallow aquifer.

Groundwater could be an exposure pathway if the shallow aquifer were used for domestic or livestock drinking water wells. The presence of metals as suspended sediment in the shallow groundwater enhances the potential for ingestion in human and animal receptors.

10.4 AIR

The principal waste sources in the Silver Creek Drainage area are the mill tailings, placer tailings and waste rock piles. Placer tailings and waste rock pile gradations are typically coarse grained containing abundant rock material. These waste sources thus contain lesser fine sediment that could be a source for airborne particulate emissions. The mill tailings typically are very fine grained to fine grained and consist of silt, sand and clay. The near surface tailings commonly exhibit floury textures which when disturbed create dust emissions.

Exposed mill tailings increase the potential for metal contaminants to be emitted as airborne particulates. Air could be an exposure pathway for particulate inhalation. Chemistry results for composite tailings samples indicate that mercury (Hg) and total cyanide would be the principal contaminants of concern for airborne particulate emissions.

11.0 POTENTIAL REPOSITORY SITE INVESTIGATION

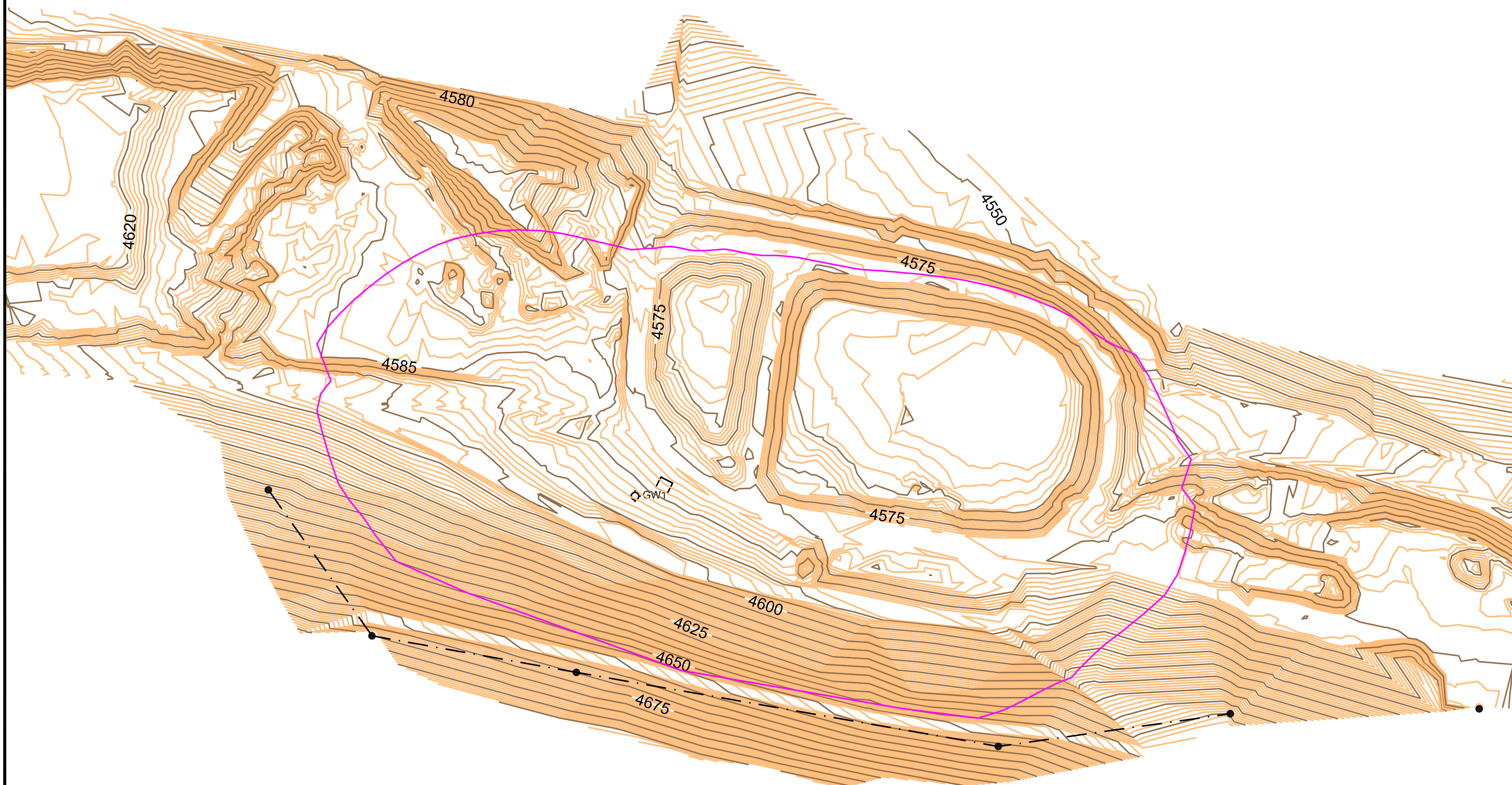
11.1 GOLDSILL TAILINGS REPOSITORY

Silver Creek and its floodplain are located in a steep, narrow, mountainous drainage basin where the land ownership is almost exclusively private. The potential areas for mine/mill waste repositories are limited. During the Phase II site characterization, a potential mine/mill waste repository site near the central portion of the Goldsil tailings area was investigated. This work involved assessing land ownership, estimating potential repository storage volume and preliminary design, construction logistics, and an evaluation of the subsurface geology and shallow groundwater.

Site characterization results indicate that the mill tailings probably represent the most significant source of contaminants for impacting human health and the environment. The total estimated volume of mill tailings in the Silver Creek drainage is 612,000 cubic yards. The mill tailings and potential borrow sources for repository cover soils are located in an area that is nearly four miles long. Given these data and logistics, a potential repository site at the Goldsil tailings area was selected for evaluation based on the following criteria:

- Area which could accommodate the estimated mill tailings volume;
- Area which would have a reasonable chance of getting land ownership approval;
- Area which would provide for an acceptable buffer zone with Silver Creek and its floodplain;
- Area which would be somewhat central to all of the mill tailings areas;
- Area which has existing potential secondary roads that could serve as haulage route(s);
- Area which is reasonably close to the largest mill tailings volume;
- Area which is a reasonable distance from potential borrow source soil cap materials; and
- Area which would require a limited amount of waste excavation to prepare a portion of the repository pad to initiate waste loading operations.

Based on the above criteria, a potential repository site was selected in the area of the lined tailings impoundment located within the Goldsil tailings area. The property is exclusively owned by the St. Louis Drumlummon Mines, Inc. Figure 11-1 shows the potential repository site area, existing topography and preliminary design. The design indicates that the repository would occupy 12.6 acres, have a maximum thickness of 70 feet, and could accommodate an estimated 654,000 cubic yards of waste. The subgrade would consist of colluvium and/or alluvium down to limestone bedrock. The depth to bedrock is estimated at 44 feet or less below the surface based on previous wells completed in bedrock by Lindsey Drilling in 1974 for Silver Creek Mining. Static water levels (December 4, 2002) in groundwater monitoring wells completed by Olympus in the potential repository area indicate that the water table in the alluvial aquifer would be 14.4 to 25.7 feet below the existing topographic surface. Groundwater flow is at a relatively steep gradient and flow direction essentially parallels Silver Creek in this area.



EXISTING TOPOGRAPHY

LEGEND

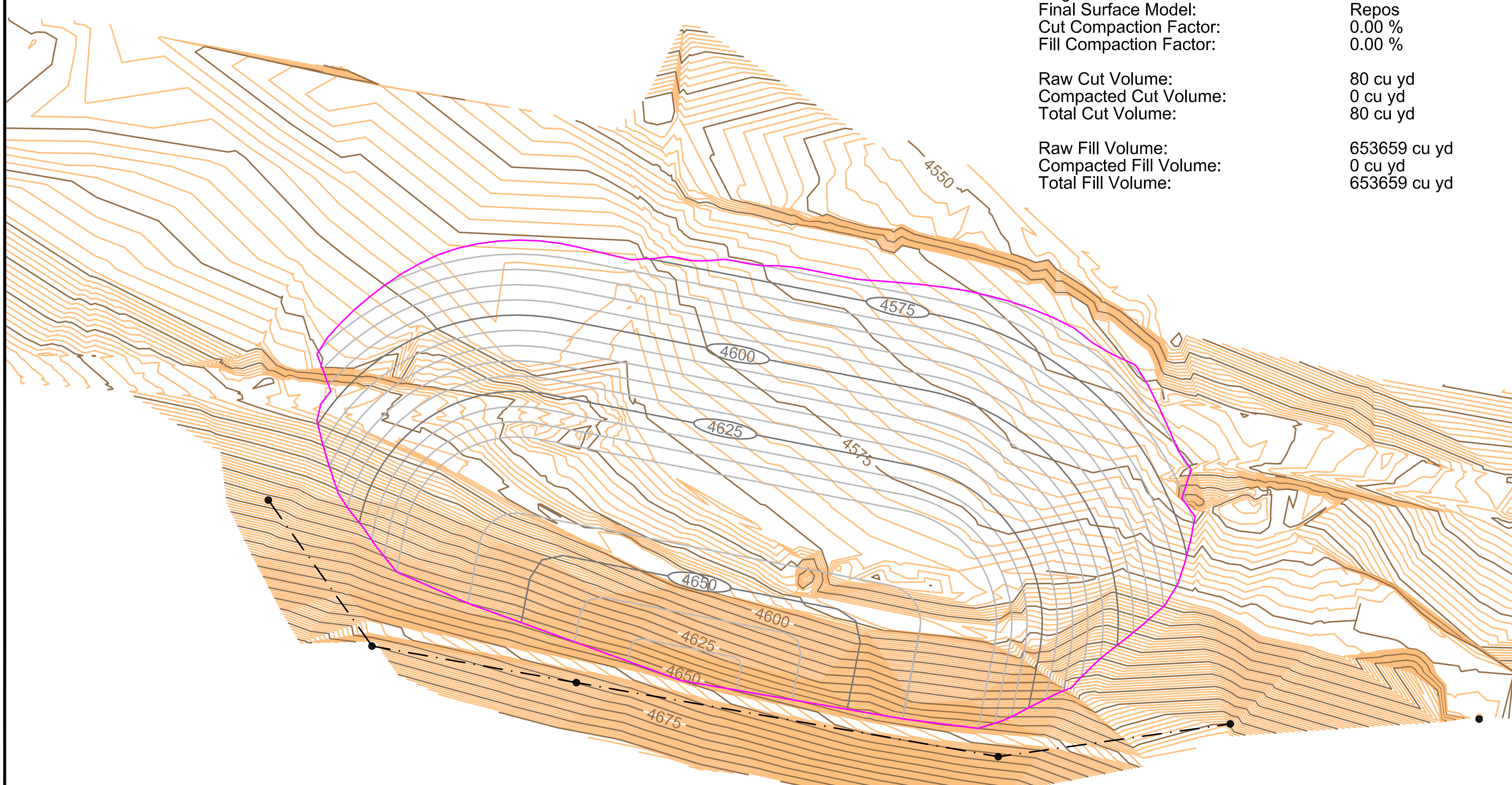
4600 EXISTING TOPOGRAPHY INDEX CONTOURS
EXISTING TOPOGRAPHY INTERMEDIATE CONTOURS
POTENTIAL REPOSITORY FOOTPRINT

0 100 200 300 400
SCALE IN FEET

N

Prismoidal Volume Results

Original Surface Model:	NatGraded
Final Surface Model:	Repos
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	80 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	80 cu yd
Raw Fill Volume:	653659 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	653659 cu yd



PRELIMINARY REPOSITORY DESIGN AND GRADED REPOSITORY BASE

LEGEND

4650 REPOSITORY INDEX CONTOUR
REPOSITORY INTERMEDIATE CONTOUR
POTENTIAL REPOSITORY FOOTPRINT
4600 GRADED REPOSITORY BASE INDEX CONTOURS
GRADED REPOSITORY BASE INTERMEDIATE CONTOURS

0 100 200 300 400
SCALE IN FEET

N

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	GOLDSIL TAILINGS AREA POTENTIAL REPOSITORY SITE	FIGURE 11-1

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 10/2002	JOB NO: A1284	SCALE: AS SHOWN	FILENAME: A1284GTRepos.dwg

11.2 DRUMLUMMON MINE OPEN PIT AREA REPOSITORY

A second repository option was evaluated in the open pit areas at the Drumlummon Mine. Figure 6-16 shows the location of the open pit areas. The purpose of a repository in this location would be two-fold: 1) to provide storage capacity for mine/mill wastes, and 2) to mitigate the highwalls associated with the open pits. Figure 11-2 shows the existing topography of the open pits and associated highwalls. There are a total of four open pit areas, labeled Pit #1, Pit #2, Pit #3 and Pit #4 (Figure 11-2). The maximum height of the highwalls associated with each of the open pits are summarized in Table 11-1. The maximum highwall height is approximately 100 feet in Pit #3.

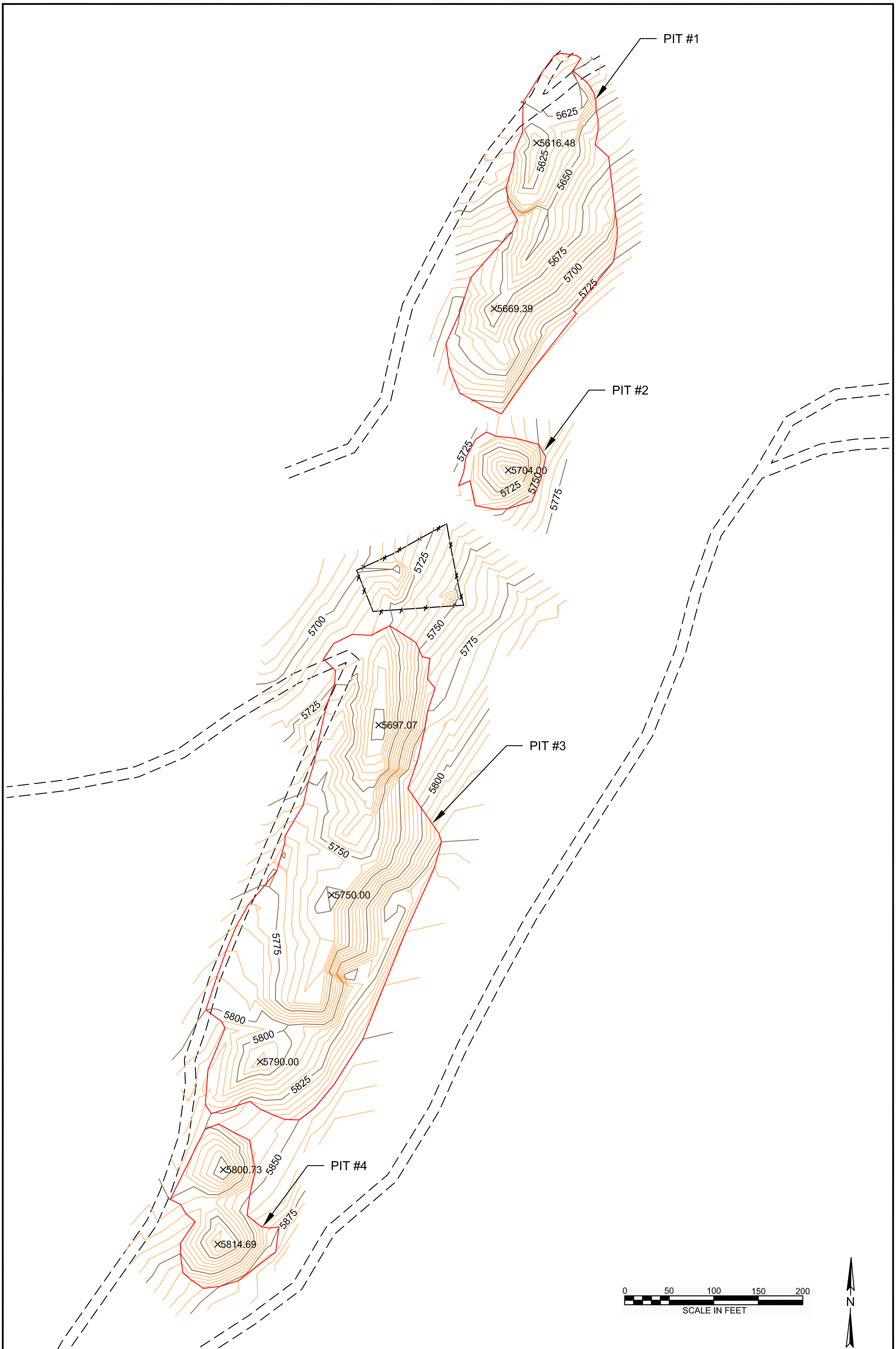
Figure 11-3 shows the preliminary design of the repository surface. The repository would be designed to completely fill each pit area, thereby mitigating the exposed highwall. Figure 11-4 shows waste depth contours and estimated volume for the each open pit. The pit volumes are summarized in Table 11-1. The combined volume of the four open pits is approximately 106,190 cubic yards. This repository would contain approximately 17 percent of the tailings and 90 percent of the waste rock that have been identified during Phases I and II of the Silver Creek Drainage Project.

TABLE 11-1 DRUMLUMMON MINE OPEN PIT AREA POTENTIAL REPOSITORY SITE VOLUME AND MAXIMUM HIGHWALL HEIGHTS

Pit No.	Estimated Volume (cubic yards)	Maximum Highwall Height (feet)
1	23,030	80
2	2,980	56
3	71,880	100
4	8,300	65
Total	106,190	

Issues that would negatively affect the use of this repository site are access and topography. The existing access road to the open pit area is steep and narrow and would require significant improvements. A culvert or temporary bridge would be required where the existing road crosses Ottawa Gulch. The final slope of the repository surface would range from approximately 1.7:1 to 3.1:1, with an average slope of approximately 2.3:1. Slopes this steep would probably be more conducive to storage of waste rock rather than tailings because of slope stability concerns.

Another issue that would need to be addressed is safety while the pit is being backfilled. The two primary issues that would need to be addressed are the stability of the highwall and the stability of the pit floor. Spalling of the highwall during repository construction would constitute a serious safety hazard for workers. Similarly, the extent of workings below the pit floor are not known. Shallow workings below the pit floor could result in cave-ins, which would pose a serious safety hazard for workers. Geophysical investigations, such as ground penetrating radar, should be completed to evaluate the subsurface conditions prior to design and construction of the repository.



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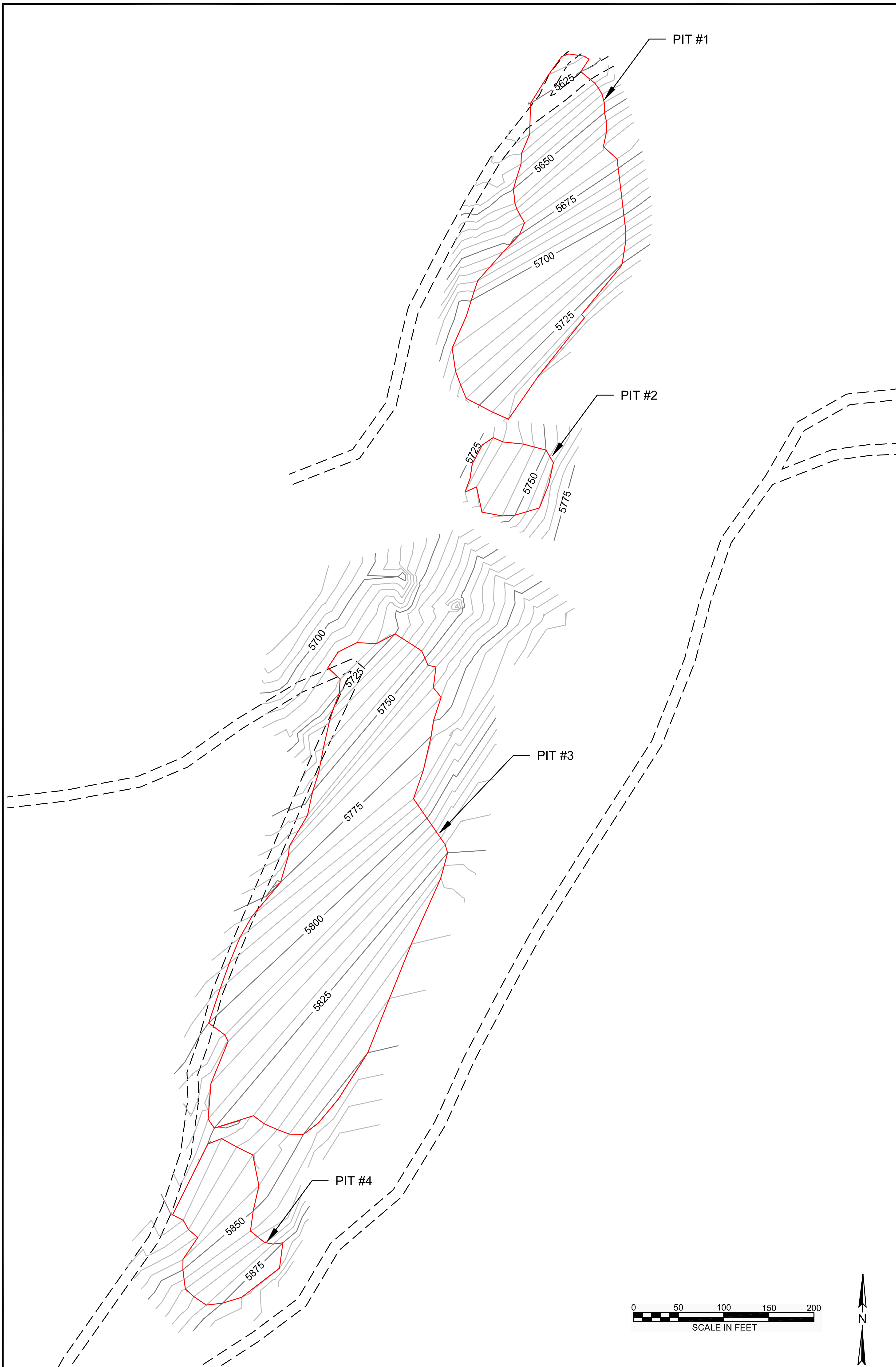
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

DRUMLUMMON MINE OPEN PIT AND HIGHWALL AREA EXISTING TOPOGRAPHY

FIGURE 11-2

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 2/2003	JOB NO: A1284	SCALE: AS SHOWN	FILENAME: A1284pits.dwg



Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

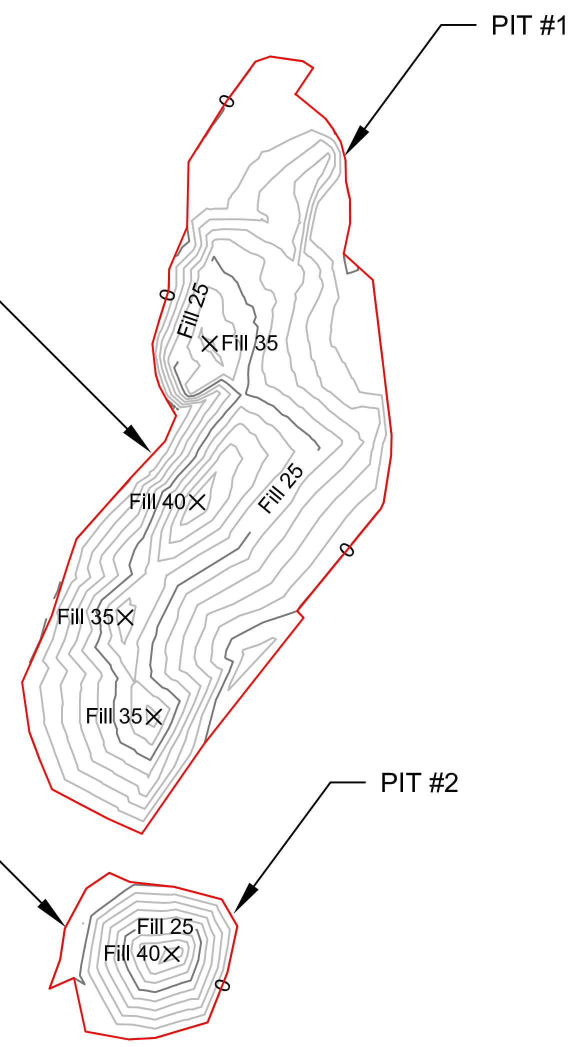
DRUMLUMMON MINE
OPEN PIT AREA
POTENTIAL REPOSITORY SITE

FIGURE
11-3

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 2/2003	JOB NO: A1284	SCALE: AS SHOWN	FILENAME: A1284pits.dwg

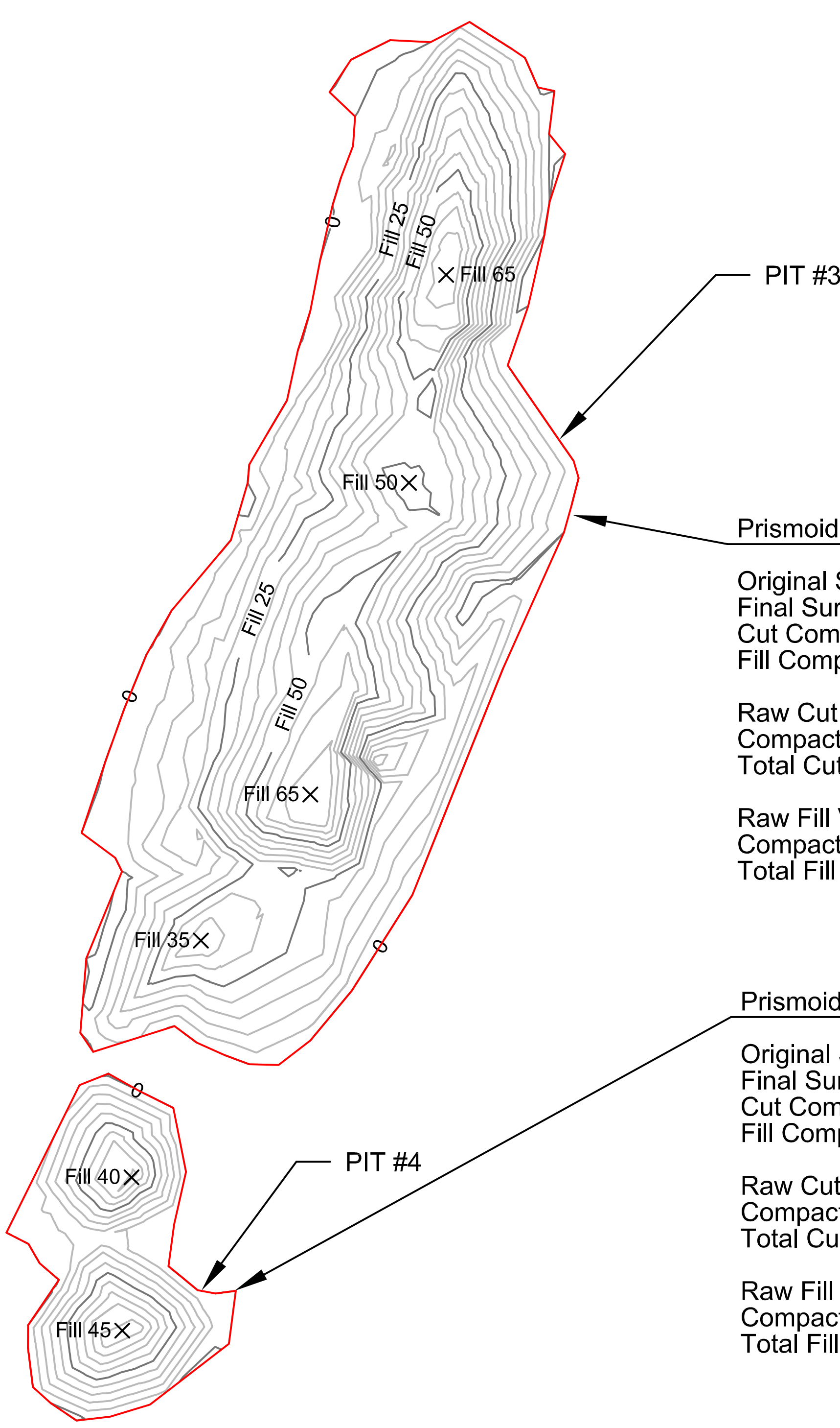
Prismoidal Volume Results

Original Surface Model:	Pit1
Final Surface Model:	Pit1top
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	112 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	112 cu yd
Raw Fill Volume:	23028 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	23028 cu yd



Prismoidal Volume Results

Original Surface Model:	Pit2
Final Surface Model:	Pit2Top
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	46 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	46 cu yd
Raw Fill Volume:	2984 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	2984 cu yd



Prismoidal Volume Results

Original Surface Model:	Pit3&4
Final Surface Model:	Pit3top
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	64 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	64 cu yd
Raw Fill Volume:	71880 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	71880 cu yd

Prismoidal Volume Results

Original Surface Model:	Pit3&4
Final Surface Model:	Pit4top
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	1 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	1 cu yd
Raw Fill Volume:	8301 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	8301 cu yd

0 50 100 150 200
SCALE IN FEET

N

Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

DRUMLUMMON MINE OPEN PIT
AREA POTENTIAL REPOSITORY
SITE WASTE DEPTH CONTOURS

FIGURE
11-4

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 2/2003	JOB NO: A1284	SCALE: AS SHOWN	FILENAME: A1284pits.dwg

Additionally, there are adit openings within the open pits. Bat habitat investigations would likely be required to determine if the open pit area repository would have significant adverse impacts on bat habitat.

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APPENDIX A

LAND OWNER ACCESS AGREEMENTS
FOR THE
SILVER CREEK DRAINAGE PROJECT

APPENDIX B

XRF ANALYTICAL RESULTS
FOR THE
SILVER CREEK DRAINAGE PROJECT

APPENDIX C

LABORATORY ANALYTICAL RESULTS
FOR THE
METALS, pH, ABA, AND TCLP
FOR SILVER CREEK DRAINAGE PROJECT

APPENDIX D

TEST PIT AND DRILL HOLE LOGS
FOR THE
SILVER CREEK DRAINAGE PROJECT

APPENDIX E

MAPS COMPARING 2002 AND

1935 TAILINGS DEPTH DATA

APPENDIX F

MONITORING WELL LOGS
FOR THE
SILVER CREEK DRAINAGE PROJECT